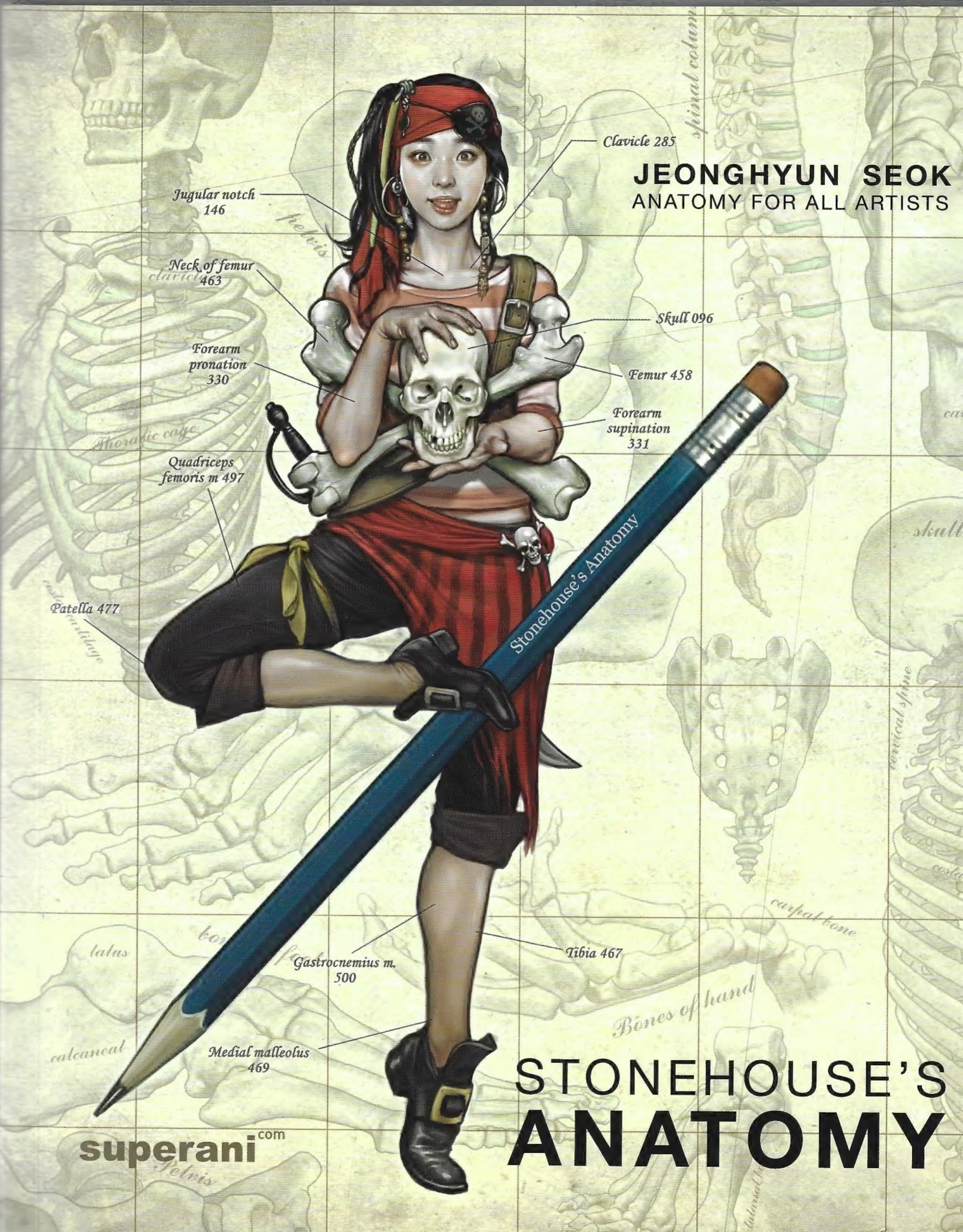
JEONGHYUN SEOK

ANATOMY FOR ALL ARTISTS



STONEHOUSE'S ANATOMY

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Anatomy for all artists

Stonehouse Anatomy Note

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Stonehouse Anatomy Note

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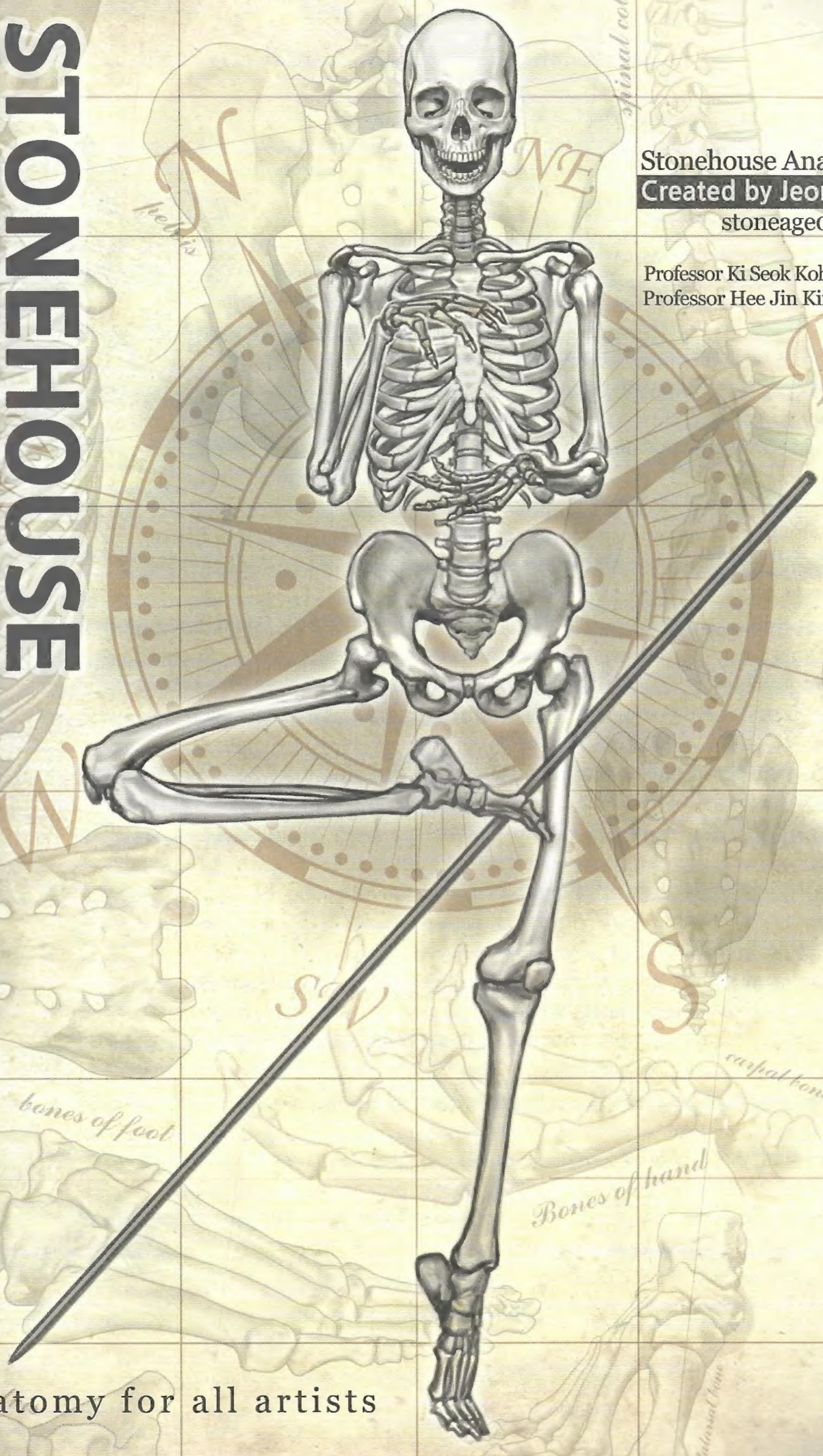

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Anatomy for all artists

Foreword

A Mecca for Anatomy Drawing

Artist Oh Se-young. A scene from the manuscript of Toseongrang.

We all want to be good at drawing.
We envy and admire those who are good at it.
So we also try our hand at drawing.
But the very first challenge that aspiring artists are met with is the drawing of people.

Human beings are the most interesting thing in this world. This is expected because, after all, we are human. Perhaps it is for this same reason that it is so difficult to draw humans.

This is especially true for artists who draw realistic drawings of people. When drawing non-human subjects, it might be possible to skimp a little on the details or cover up a shortcoming with some clever technique, but this doesn't work when drawing people. You will be found out right away. That is why we have to study anatomy, even if we wish we could draw well without effort…

Of course, there are some people with innate talent who can draw more appealingly than people who studied art. But the truth is, I and many others struggle. Drawings of people are the most interesting. But it is so difficult to draw them well!
As an artist, I had been drawing human characters for some time and could pass myself off as one too, but one day I saw a drawing by the artist Oh Se-young. I almost fell backwards in surprise. How could someone draw human characters so well?

My wishful thinking was that I wanted to be the best artist!
I looked closely at artist Oh Se-young's drawing. The perfect dessin, the clothes, wrinkles, facial expression and even smell were depicted in that drawing. I exclaimed in admiration. I felt so proud and envious of him! He was like a treasure in Korea's history of drawing! Sometime later artist Oh Se-young, along with Professor Lee Hee-jae, became my best friends.

I learned his secret that his talent came from practicing. One day, when Oh Se-young was 17 years old, his teacher Mr. Oh Myeong-chun sent fifty sheets of practice paper with a letter.
"If your drawing isn't going well, go up to the mountains to cry alone. But never turn away from your desk." Thanks to having such a teacher, Oh Se-young had practiced and practiced drawing each part of the human body.
The result was the perfect drawing I saw before my eyes.

I realized, "This is why studying is so important!"
Artist Oh Se-young and Lee Hee-jae became my teachers. As for Lee Hee-jae, his talent was in drawing all people and subjects in his own style without being too caught up in anatomy.
I decided to teach anatomy class in school. It was so that I could study too.
My passion for anatomy was at its highest when I met Seok Jung-hyun, now called "Seokga," as a student in my class. Not only did he draw amazingly well, but he was also passionate about drawing the human anatomy. I was reminded of Oh Se-young.
I came to have an ambitious dream.
Korea would become the mecca of anatomy drawing! I believed this was possible.
There were artists like Oh Se-young, myself, and Seok Jung-hyun who could make this come true.
I encouraged Seokga to write a book on anatomy drawing. Of course, I also suggested this to Oh Se-young. If we could publish such a book, Korea could become the mecca of anatomy drawing.
Every country's culture should be different, but its art should have a basis on realistic anatomy drawing. Korea had a weak foundation in this regard. Korean artists didn't like to study. I am not saying that it is mandatory to study anatomy. One can become a great painter and cartoonist without studying anatomy.
However, if an artist does that, something inside him will nag him. If the artist was aware of where his skills stood and was willing to accept that and continue drawing with confidence, then he was welcome to create his own world and his own style. But if he suspected that something was not right, wouldn't it be better for him to study? If the artist doesn't study, he will live the rest of his days feeling that something is missing. Imagine how good it would feel to study and find the solution for each problem! How great!

Ten years ago, Oh Se-young, Lee Hee-jae, and some other cartoonists gathered at Oh Se-young's home in Anseong to form the Dal Toki drawing group (The group was named Dal Toki because in Korean it meant that we would gather on the last Saturday of every month to draw croquis). It became a gathering where we could continue studying. We held exhibitions and published a book. Then, our study group did not meet for a while and then last year in May, Professor Oh Se-young passed away. I was very sad and heartbroken to lose a great talent. To leave so soon when he had so much more to give! Upon hearing the news of his passing, Seokga sat with his back turned and wept quietly for a long time.

And then, six months later, Seokga called me.
"Professor, I have published a book on anatomy. Could you write a recommendation review for it?"

“Really?
“Yes.”

I reviewed the book and was amazed. Everything was perfect,
from the big outline to the smallest of details. Readers would be able to study anatomy
with ease and fun in a detailed manner.

I found myself saying, “This is world-class level!”
I went on to say, “Korea will now definitely become the mecca for anatomy drawing!”
In fact, with the publication of this book, I think Korea has already planted a flag as the mecca.
I am teaching another anatomy drawing class this year.
I had learned from Oh Se-young and now I am learning again from Seokga.

If I study and practice endlessly, I will one day be able to draw something great that
will even surprise me. I am so happy that just as Seokga studied with my books,
I am able to study with Seokga’s book.
In addition, I am excited that in this semester, students are going to be using
Seokga’s anatomy book as their textbook.

I am enthused that many people who want to draw anatomy will be able to
approach the subject more easily and with greater interest!

Seokga, congratulations on your hard work!
It took a total of ten years!

January 2017

Park Jae-dong (Cartoon Artist, Professor at Korea National University of Arts)

I remember my first meeting with Seok Jung-hyun, an artist who worked by the penname Seokga, at the 2010 "First Da Vinci Academy." I remember thinking that Seokga was different. That first impression was to last. Seokga impressed many people through the numerous anatomy classes he taught to college students, and the special lectures he gave to professors of anatomy at the Korean Association of Physical Anthropologists conference. This is how my story with Seokga begins.

Not long ago, Seokga brought me a draft copy of Seokga's Notes on Anatomy that he had worked on for long, and asked me to review it. I was really surprised that a cartoon artist, who didn't major in anatomy, could describe the human anatomy so realistically and so well. I felt that the book was the aggregation of great passions that were far bigger than Seokga's own curiosity about a subject that could not be easily approached by the public.

The study of anatomy is mandatory for those who study medicine, but it is a special discipline that can only be fully understood by dissecting a body. Of course, the general public should also have some very basic knowledge of anatomy, but because of the above mentioned limitations, the subject is difficult to approach.

In particular, those who major in art or physical education must understand and be able to explain about the structure of the body even though they did not have the chance to dissect a body. This book will surely fill in that gap and be a welcome material for students of many different disciplines.

As an anatomist, I truly hope that Seokga's Notes on Anatomy will become a must-read textbook for students of the arts and physical education, especially because those disciplines emphasize the dynamic movements of the body, which is so well explained in the book. On behalf of all the students that study anatomy, I want to congratulate and pay my respect to Seokga.

Kim Hee-jin, Professor of Anatomy and Developmental Biology Lab at Yonsei University College of Dentistry

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Among the many books on the human body, there is no other book that is more enjoyable, funny, and clearly written! This is an analysis report on the human body, for the human body, by the human body prepared by artist Seok Jung-hyun over a long period of time. This book presents clear and easy to understand knowledge of the human body, and the author's witty original illustrations add fun and draw out the readers' participation. As a person who manufactures figures, I thank you so much, again and again for this book. Bravo! I am so glad that we finally have a proper textbook on anatomical drawing!

Hong Jin-cheol (CEO, Hot Toys Production Korea)

A book on anatomy that has been redefined from the view of an artist! I have been waiting for such a book for a long time! The fruit of Seok Jung-hyun's efforts will be like a welcome rain in the dry season for many artists.

Yeon Sang-ho
(Busan, Seoul Station, The King of Pigs, Saibi)

I was really surprised while working with Seok Jung-hyun. I'm a sports trainer and I have spoken to many people in this field, but I have never met someone who had such an accurate understanding about muscles. Artist Seok Jung-hyun worked on this book with determined perseverance over a period of ten years. A great book that has never been written before and that never will be written again.

Jo Sung-joon (Trainer, Author of Shut Up and DeSLun)

A book on anatomy that hits the nail on the head. For beginners and professionals alike, this book has a lot to offer to anyone who reads it. Great work, Seokga!
(I'm sure that my appearance in this book increases the credibility of this book! Ha!)

Kim Jung-Gi (Drawing Artist)

During a special episode of the TV program "2 Days & 1 Night at Harbin" artist Seok Jung-hyun drew a cartoon of the independence activist Ahn Jung-geun. The face and gesture in the drawing brought to life a historical event that is depicted as a single line in textbooks.
This book contains the secret of how the artist could instill such complex psychology into an illustration on paper.
From the small muscles of the face that express delicate emotions to the large skeletal structures of the human body that depict dynamic movement, the book explains about the scientific logic behind every artistic expression of the movement of the human body.
The process of following the author's explanations of how and why the human body should be drawn in a certain way-for example, using knowledge on physics to explain about men's shoulder muscles and the evolutionary explanation about women's legs-is very interesting and enjoyable for artists and the general public alike.

Seokga's book has amazingly vivid illustrations and in-depth information that are delivered in an entertaining way, making the process of drawing even more enjoyable. Once readers understand the vectors of the body through this book, they will be able to draw human movements that they previously used to memorize as a few patterns in much more diverse ways.
If a character that only frowned his eyebrows begins to frown with his hands and back also, that character will be ready to play the protagonist in the story.

Producer Ryu Hojin (KBS TV program "2 Days & 1 Night")

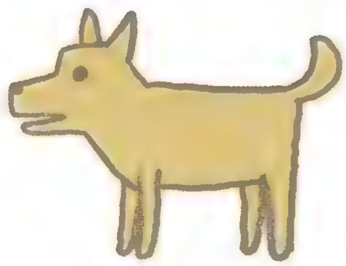
A long time ago, I heard Seok Jung-hyun say that he was going to write a book on anatomy. Many years passed and I forgot about this. However, during all that time, Seok Jung-hyun had been slowly but steadily writing the book. Finally, we see the result.
I saw the book before anyone else in order to write a review, and I was shocked by what I saw. The pressure that I had initially felt to find something positive to say about the book disappeared, and I found myself reading through the pages and thoroughly enjoying it.
I was very thankful for this book because I had always felt that I did not have a strong basic foundation. This book is not written in a way that asks difficult questions like 'What are the basics of drawing?', 'What are the basics of the human body?', 'Why don't you know this?' Instead, it feels like the author is sitting next to me and kindly explaining everything. I would recommend this book to many artists.
I expect that this book will become the textbook of many artists for a long time. I recommend Seokga's Notes on Anatomy with confidence.

Kang Full (Cartoonist)

Preface

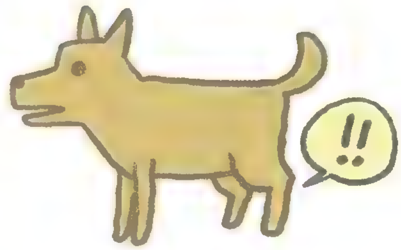
The mystery of dogs' hind legs

The very first time I felt interest in anatomy was when I was in second grade in elementary school. I liked to draw and be praised for it. Like any other child, I also liked dogs very much. And it was natural to draw something I liked. This is how I first drew dogs.



As you can see, my drawing of a dog was like that of any other child. However, I came to feel that my dog drawing was 'somewhat lacking.' This was after my father had bought me an encyclopedia and I had carefully studied pictures of 'real dogs.'
What was the difference between my drawing and the picture of the real dog?

Staring at the page in the encyclopedia, I pondered for a long time and suddenly discovered an important fact.
The hind legs of real dogs were bent! My young self was shocked by this great discovery. It was as if Archimedes discovered the law of buoyancy in the bath and shouted "Eureka!"
I immediately applied this finding to my drawing.



Unbelievable! My drawing of the dog looked so much more like a real dog. At the time, I didn't have a real dog because my family lived in an apartment, but this discovery made me as elated as if I had gotten a real dog. As expected, when I showed the drawing to my mother, she was very surprised.

laugh when I think about it now. But the shock I felt at the time was so great that I still remember it vividly thirty years later.

Anyway, after making this discovery, I naturally came to ask the next question.

'Why are dogs' hind legs bent? Why don't my legs look like that? The hind legs of deer, giraffes, and tigers are all bent as well. But why not the legs of humans?'

However, it wasn't easy for a second grader to find the answer. For starters, I was very shy and introverted. I couldn't get a clear answer from my parents so one day I mustered the courage to ask my teacher,

"Why do the dogs' hind legs look like they do?"

I became a laughingstock to the whole class, and my face turned red. My teacher, who happened to be a devout Christian, answered me in a solemn voice.

'Sigh… Ma'am, that's not the answer I am looking for. God must have had a reason for creating dogs' hind legs that way!' I wish I had said this out loud then, but I just nodded my head with the expression 'Ah, I see.' As I said, I was an extremely timid child.

I couldn't solve the mystery of dogs' hind legs for a long time, but I did continue to draw, and as I became older, I slowly lost my curiosity about dogs' hind legs.

Why? I just accepted the fact that it looked like that because it did.

Looking back, I understand why the adults were less than enthusiastic about answering my question. It would have been very tiring for adults to have children asking them questions about something the adults accepted as is. Moreover, there was so much to worry about in this world, why care about dogs' hind legs?

Later, I entered art college, and spent more days drinking than drawing. Then, I went to the army for my mandatory military service.
As you know, there's a lot of training and running in the army. My feet, which never had to run so much before, got blisters and scars.

One night, my feet hurt even more than usual. I woke up to massage my sore feet. Then, I noticed something. It wasn't my entire feet that hurt, it was just the front part. Suddenly, I felt something click in my mind like that time I discovered the bend in the dog's leg.

That was it! I realized that when a person runs, the shape of human legs resembles that of a dog's hind leg. The dog's hind legs and human legs actually had very similar structures! At that moment, the question I had had for so long was answered.

The difference between human legs and dogs' hind legs was the obvious fact that 'humans walk on two feet, not four.' It was some time later that I learned that humans' feet had evolved to hold up the body weight for humans to stand up straight, rather than to run.

Soon after, I learned that a dog's front leg also had similarities with the human hand. Only, in the case of humans, the 'front limbs' had evolved into hands so that they could hold things and make tools, rather than having evolved for mobility. In turn, the evolution of the hand had the effect of developing human intelligence, and humans, in order to compensate for our disadvantage in mobility compared to other animals, made continuous efforts to improve mobility, creating the current world we are living in. And the most important fact was that I came to realize that the truth can be hiding somewhere or in something we take for granted.

There are countless other things like the dog's hind legs that we take for granted and overlook. I think the one thing we overlook the most is our body, its shape and the stories related to it. We take our body for granted because it is ours. But think about it. When do we ever pay attention to our body? Only when our bodies get sick.

Knowing the structure of our bodies and feeling awe for it are not duties or privileges granted only to doctors and artists. Anyone with a body should have some basic knowledge of anatomy.

Each one of us can be compared to a self-made person who was picked out of a competition with a ratio of 300 million to one to join a company, then became CEOs of a giant company called 'body' that has an average of 60 trillion employees. But if the CEO doesn't even know what his company looks like from the outside, how could that company operate? Or actually, would you even be able to confidently claim that it is your company?

Learning about your body is the first step to loving yourself. And moreover, it's a must for artists who have a duty to express people and give people hope and enlightenment.

I think my job as an artist is to shed new light on what we see and take for granted, and send a message through art. Perhaps my childhood curiosity about dogs' hind legs was the beginning of my fate to become an artist.

The story on anatomy that I am about to begin is a series of stories like the "dog's hind legs" that I learned while studying anatomy. I'm not a biologist or a doctor, so this book might have some shortcomings, but I think it is exactly for this reason that I was able to explain the difficult subject of anatomy from a different perspective. I hope that this book will serve as grounding for those who study art like me to be able to express the human body in a more professional style, and for the general reader, serve as a guideline for learning about our body and for understanding and loving ourselves and others.

Author/ Artist **Seok Jeong-hyun**

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'Birth of a monster' / Painter pencil brushes / 2009
Although they come in all shapes and sizes, living organisms share one purpose. That is, to eat or be eaten.

I

The Appearance of a 'Living Organism'

The process of 'human' becoming 'human'

In the same way a sperm, a mere microorganism with a tail, becomes a fetus with a human form. The baby then goes through changes in appearance with each passing year, just as humanity has changed in appearance since the beginning of our long history.

Imagining the world before humans is essential to understanding the unique form and appearance of human beings.

So, let's embark on this journey with a light heart.

Definition of Living Organism

There is one thing we need to address before we study the 'human body.'
And that is the fact that the 'human body' is a living thing.
If you're asking why I'm stating the obvious, it's because 'pictures' are a genre of art that is essentially without 'life,' and in some ways has a very limited range of expression. Therefore, the expression 'breathing life into a picture' is circumstantial evidence that the 'picture' itself doesn't have life.

The act of drawing the human body means to depict a scene from life. In other words, to draw living subjects, it is necessary to contemplate about 'life' itself.

It is the same as needing to experience love before you can write a love song.

A picture is a form of 'expression,' and it is impossible to express something that we don't understand. A person with only a superficial knowledge of anatomy and knows nothing about 'life' can never express 'vitality.' There is a line in the Korean biographical movie Painted Fire, about the genius painter Owon Jang Seung-eop, that goes:

Of course, a rock is an 'inanimate object.' That is because a rock can't move of its own will. However we can 'breathe life' into any subject matter in a 'picture' so that it looks alive. The question is whether the artist has the desire to express vitality no matter what subject matter it is.
I wish the person I'm drawing looked like they were really alive! If this is our wish, then we need to seriously think about what it means to be 'alive,' do you understand?

Now, defining 'life' may seem like a highly difficult and grandiose task and rightly so as the basis for categorizing living organism and inanimate objects are complex and ambiguous, with studies such as biology, medical science, anthropology, philosophy and others differing in perspectives and standards.

That is why, first, we need to narrow the word down to 'living organism.' It means that which has 'life.' This is how 'living organism' is defined according to the dictionary.

living organism [생물, 生物]
a living thing made up of one or more cells and able to carry on the activities of life (as using energy, growing, or reproducing) [Merriam- Webster Dictionary]

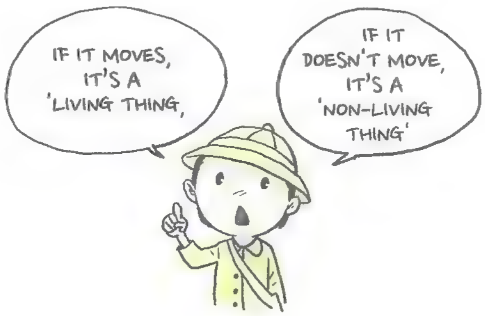
An articulate dictionary definition, but without an accessible meaning. It's not easy to get a clear answer when we ask what 'living organism' means. But the way I define 'living organisms' and 'non-living organisms' is quite simple, and I hope you can approach it simply, too. Now, I will ask again.

What is a 'living organism?'

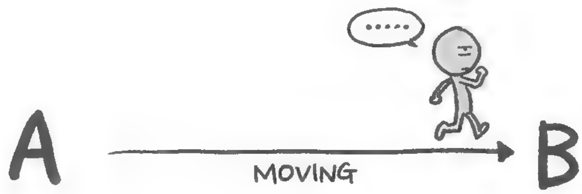
Though I've said to make it simple, I bet many of you were hesitating. That is because we've all been well educated about what a 'living organism' is throughout our elementary, middle and high school years. Sometimes knowing too much can be a hindrance.

Then let's change the wording and ask a kindergartner the same question.

'What is the difference between living things and non-living things?'



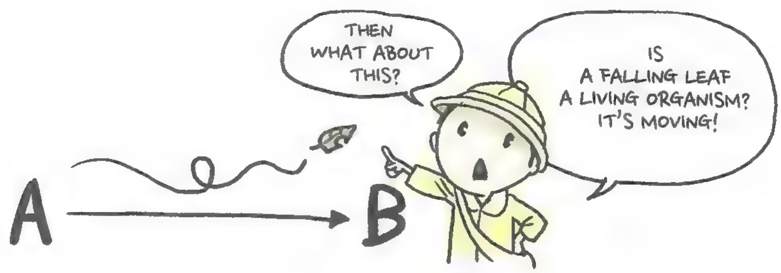
Did the child's ingenuous answer make you smile? We sometimes easily neglect the 'obvious facts.' But sometimes, those obvious facts are often the answer. The child's answer is not that different from my thoughts on the definition of living organism.
It's something like this.



If it's moving it's a living organism, and if it's not moving then it's a non-living organism.
Is this a joke, you ask?

The act of moving is a very important thing to maintain life. Why? Because we move to keep ourselves alive. We move in order to look for food, run from danger and to reproduce.

One might refute this with the argument;



Let's read the definition of living organism once again.

"A living thing made up of one or more cells and able to carry on the activities of life (as using energy, growing, or reproducing) [Merriam- Webster Dictionary"

Let's focus on the term, 'able to carry on'. This means the living organism has to be able to move by its own will.

In other words, the existence of a 'will' of its own is more crucial than that of 'movement' when it comes to defining whether matter is a living organism or not. Then how is 'will' formed? 'Will' is formed through many different kinds of needs. I've briefly mentioned this earlier, but they form by following examples.

Desire to eat

Desire to procreate

Desire for self-preservation

As you can see from the above images, we can say that protecting one's self from danger, looking for food, wanting to pass one's DNA to the future generation, etc. can all be included in survival needs. So being alive means the process of actively moving to fulfill these needs.

On a broader spectrum, traveling, or reading books (experience, acquiring knowledge – consumption), drinking and talking with friends (exchanging information – protecting one's self), commenting on social media or writing books (spreading ideas – procreation) is all a part of exposing your existence to others and confirming that you are alive.

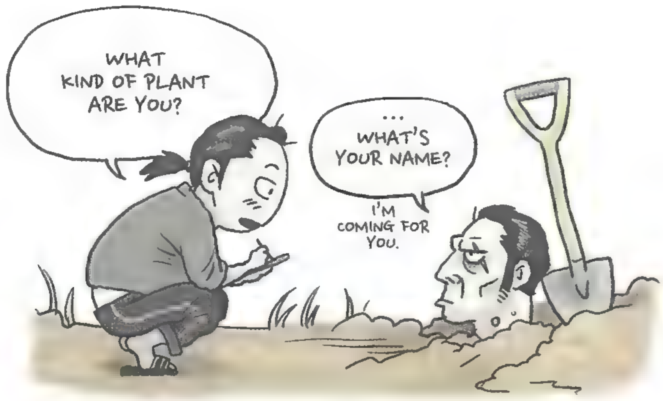
To summarize, we can define a 'living organism' as a being that moves according to their survival needs.

An example of 'will' without movement which raises the question of whether he's alive or not. 'Movement' becomes an important basis when investigating what a life form is.

We've defined that one has to 'move on its own will' in order to be a 'living organism,' then someone could ask this question.

There are over 2,000,000 known living organisms but only three to four categories in which to group them. Generally, they are divided into animals and plants. Also, depending on the circumstances these groups are divided either into animal, plants and microorganisms or animals, plants and bacteria.

But for this purpose, we will be exploring the general classifications of 'animals' and 'plants.' This is simple. 'Animals' can 'move voluntarily,' and 'plants' are 'planted in a permanent site.' Just because they are planted doesn't mean they are not moving, so animals and plants are not a contrary concept to each other.



Plants move as well. We are just not aware of their movement because it is very slow. We must not overlook the fact that plants move according to nutrient and sunlight needs.

'Mimosa' and 'Flytrap' are the fastest moving among the plants. They are the classic examples of 'moving' plants as they move to protect or absorb nutrients.

I cannot emphasize this enough, but please remember that both animals and plants move on their own will.
The 'human body' we will be exploring from now on can also be included in the animal category. Their appearance and their components are structured so that can move efficiently and freely. If we add 'movement' to our considerations, it will be much easier to understand human anatomy.

The Form of a Living Organism

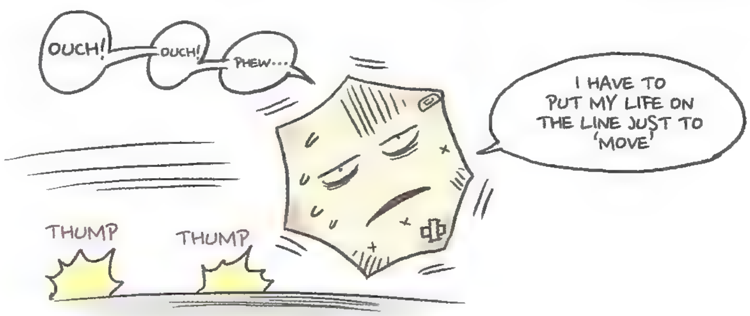
■The Ideal Form of an Animal

Many people get life and life form mixed up. It may sound similar, but they are very different. 'Life' is the power to move with a will, while 'life form' is a vessel that holds life.

Therefore, the primary function of a 'life form' is to protect one's life.
Then, what would be the most ideal form of a 'life form,' or 'living organism?'

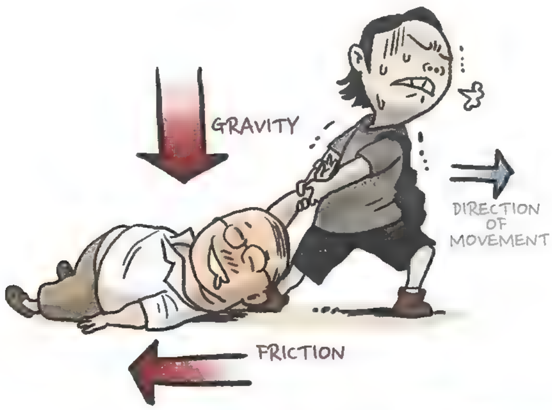
Would this be the most efficient form, if it has to contain life?

In fact, a sphere is probably the closest to being perfect in terms of all the shapes in existence. Even at a glance, the sphere is a very efficient shape as it can move easily and also protect itself from an external force.

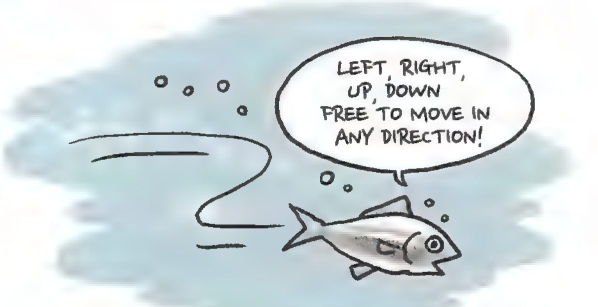


a purpose of a 'life form' is to protect one's precious 'life.' Therefore, to contain 'life,' isn't a a perfect vessel for that job?

s, hardly any life form on Earth has the shape of a sphere.
because there are invisible forces on Earth at play called gravity and friction. No life form on escape from these forces.



a bit better in the water where gravity a relatively weaker effect than on earth,

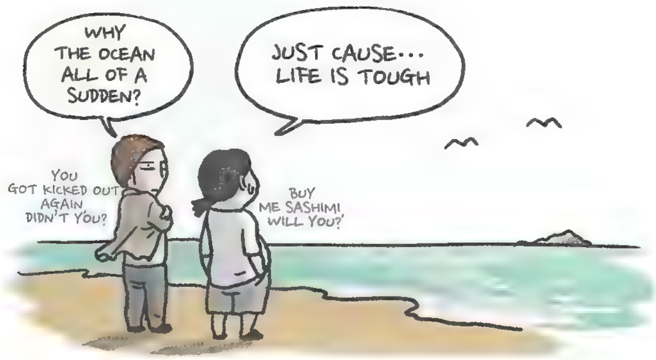


There are more living organisms with streamlined forms or in the shape of the ellipse, a shape close to a sphere, in the water than on land.

It probably wasn't easy to move on land with forces such as air pressure, unpredictable changes in temperature, and harmful rays, let alone gravity and friction. Every living being on earth needed a 'device,' or 'organs,' to overcome these obstacles and external pressures, and thus ended up with their unique, complex forms.

Example of a vertebrate failing to adapt to earth life. That is why he's turning more into a sphere-like shape!

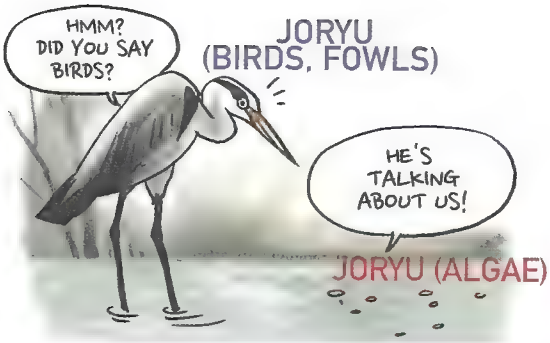
Perhaps we wouldn't even need to be sitting here studying anatomy if we had continued to live in the ocean. A question comes to mind right about now. Why would human beings and many other life forms risk their lives and struggle to come to earth, leaving the cradle of life called the ocean?



■LEAVING THE OCEAN

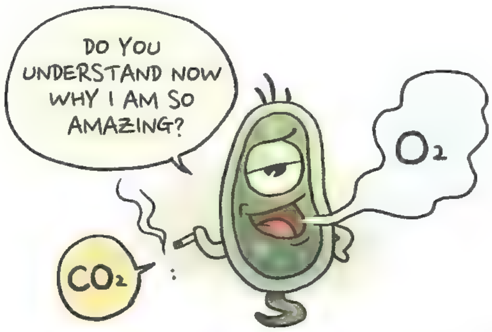
Let's briefly review the history of life forms to understand why most mammals, including the human race, decided to leave the ocean. 'Do we really need to know all this?' you might ask, but this is the first step in learning about our external shape and the structure of our body.

Roughly about 34 billion years ago, when most of the earth was covered in ocean, the first life forms came ashore. It was algae, the single-celled organism that is the ancestors of the planktons.



Algae is a large, diverse group of photosynthetic organisms that are not necessarily closely related, and is thus polyphyletic.

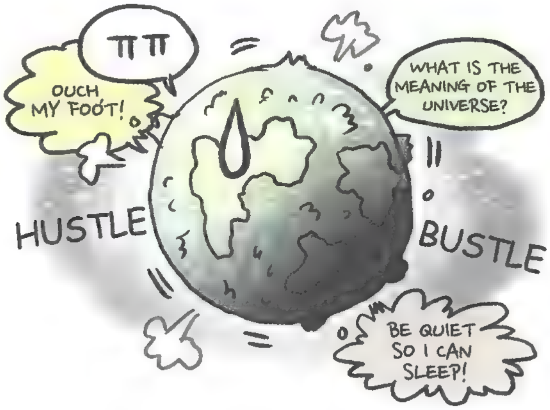
... the earth, full of water and carbon dioxide, was the perfect environment for the algae to thrive because they could generate energy as long as there was water and carbon dioxide.



Photosynthesis, which uses light to absorb carbon dioxide to generate energy and produce oxygen, was possible due to a gift of nature called 'chlorophyll'.
('Plankton' Characters Design Nickelodeon. Spongebob Squarepants)

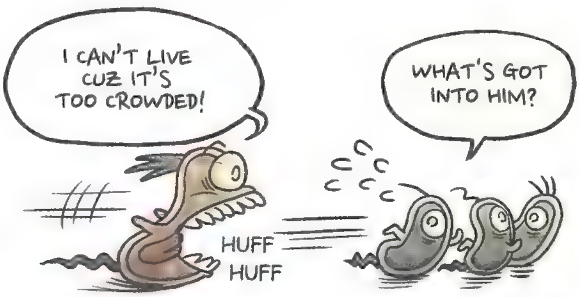
For this first ever life form, the ocean was a paradise. Furthermore, there weren't any 'threats' present at the time.

Their number could only grow due to these circumstances. Moreover, not too long after, volcanic activity caused the land to rise from the ocean and the ocean was oversaturated with single-celled creatures.



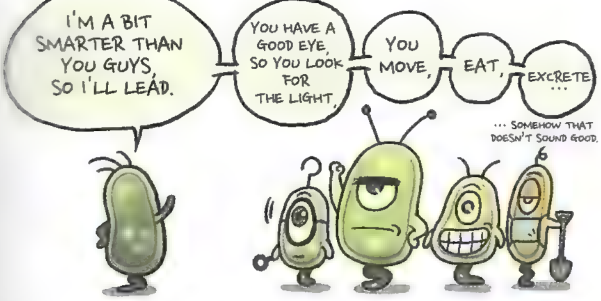
The planktons that covered the Earth produced about 20 quadrillion ton of
oxygen through photosynthesis, and it created the atmosphere and the ozone layer.
Even now, ¾ of the oxygen that covers the Earth is from marine algae!
We are greatly indebted to planktons since we cannot survive without oxygen.

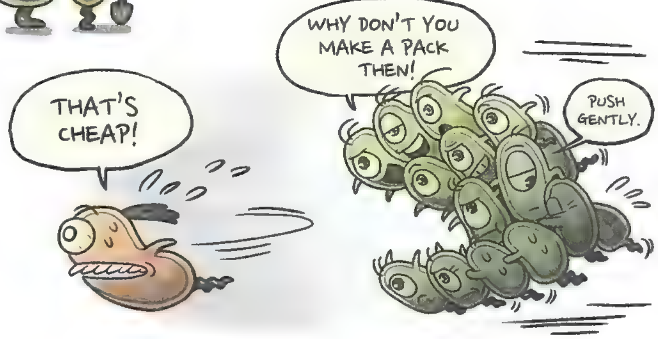
Now, here's a question.
What would happen when an individual is endlessly multiplying while resources and space are limited?
That's right. They will be divided into predator and prey, the 'one that eats,' and the 'one that is eate



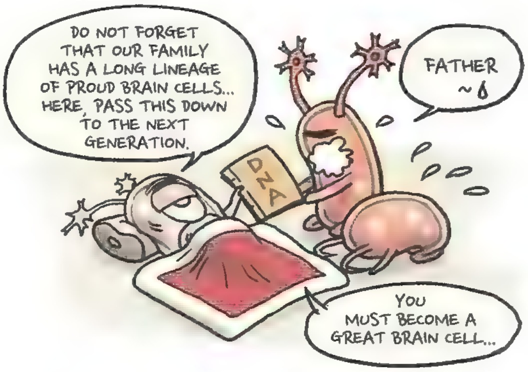
Because predators need to feed and the preys need to survive, they now have a reason to move!
Needless to point out that the reason is 'survival.'

These guys started to agglomerate, in order to move more efficiently and to protect themselves. That way they felt safer than being alone. Both the predators and the prey needed a more efficient way to hunt and defend themselves so cooperation between cells became necessary. Thus, an alliance was formed.



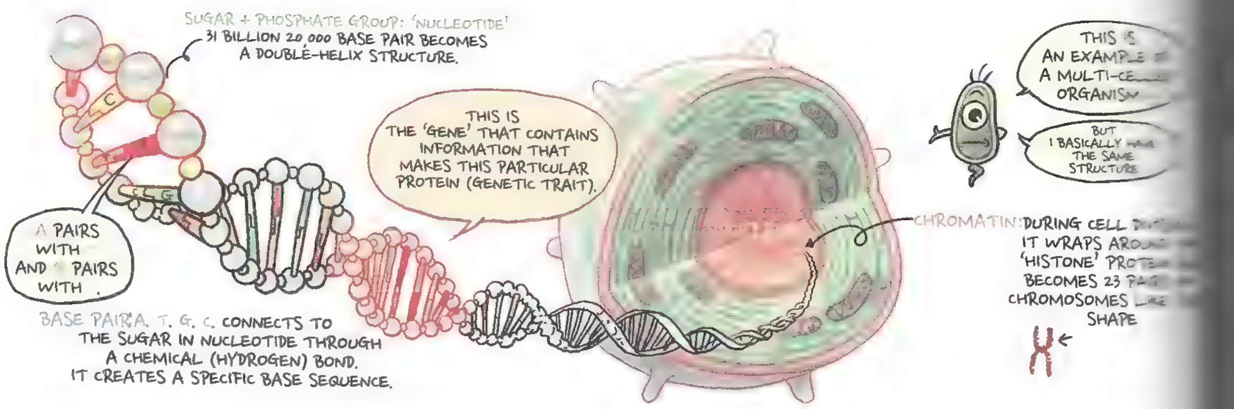


The agglomerated single-cells each took a role of the brain, nerve, movement, senses, etc. and enhanced their functionalities. Their roles became more specialized as time went on, and they acquired more efficient survival data through trial-and-error and modifications over time. These changes were passed down to the next generation.



Evolution must occur from a living organism's desire to leave a descendant that is more fitted for survival.

This data is called genes. Genes are a sequence of DNA (Deoxyribonucleic acid). DNA is a thread-like chain of nucleotides carrying genetic instructions (please refer to the image on the next page).



The simple structure of a DNA - Base are marked with the first letter of Adenine (A), Thymine (T), Guanine (G) and Cytosine (C).
('Plankton' © Nickelodeon)

Wait! The Gene Map and the Genome Project

As you can see from the image above, 'base sequence' is a sequence of base pair (A-T, G-C) that connects the 'nucleotide,' which consists of 'sugar' and a 'phosphate group,' into a double helix under a specific rule of genetic information.

The 'Human Genome Project' was none other than an attempt to figure out the base sequence of a genetic data.

It was a project of incredible scale to get close to the essence of life, considered the realm of God, by figuring out the genes of over 31 billion 20 thousand base pairs of human DNA. Then, why did us humans want to create the genetic map so badly?

The physical nature of a 'race' was divided because of this 'genomic information.' There is no reason to choose the same survival strategy if the environments that surround the life forms are different. Even within the same 'human' race, their physical nature is changed depending on the environment they are in.

People who live in the cold polar regions tend to have a thicker body and stockier arms and legs to retain heat and possess developed resourcefulness, whereas people who live in the hot equatorial regions tend to have a larger and longer body surface area and show aspects of advanced motor ability.

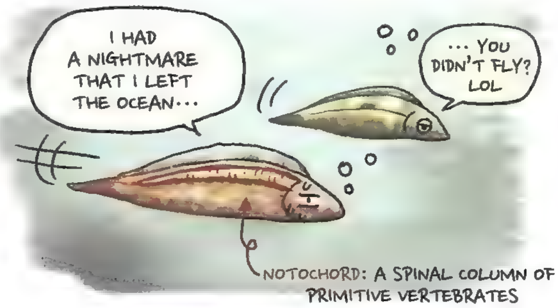
Although there is a saying that man is the lord of all creations, humans are still imperfect in many ways. Hairless skin, weak spine due to standing upright in an evolutionary haste, susceptibility to thousands of illnesses and drastic aging after a certain point prove just that (although this isn't just a problem for humans).

Could we create a new human race that can overcome various illnesses by picking and combining the genes from species that have adapted to and survived the various environments?'
This was the starting point for the genome project. That is why the genome project that completed in the year 2003, along with stem cell research, is still not free from religious, ethical and moral controversies. Although the project started in 1990 and completed in 2003, we've only figured out the location of the genes, and we're still figuring out what kind of functionalities they possess. It looks like we have long ways to go from reaching the dream of 'creating life.'

As for life forms that have formed an 'alliance' based on their genetic code, they either cover their bodies with hard shells,

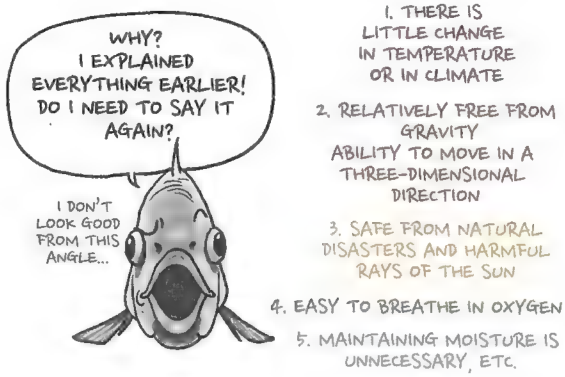
Arthropods, which ruled the ocean at the beginning of time and later evolved into insects, scorpions, and spiders, had limited range of motion due to the hard exoskeletons that wrapped their bodies.

or develop a strong column or frame inside their soft skins, etc. as their survival strategy.

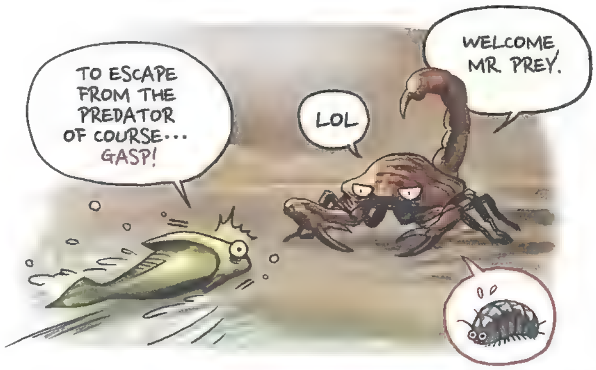


'Haikouichthys,' the first chordate, Is considered to be the ancestor of all vertebrates including birds, used a primitive spinal column called 'notochord'to move its tail left and right to swim.

Although the ocean became a battlefield for survival, it was still considered a safe environment compared to the land.

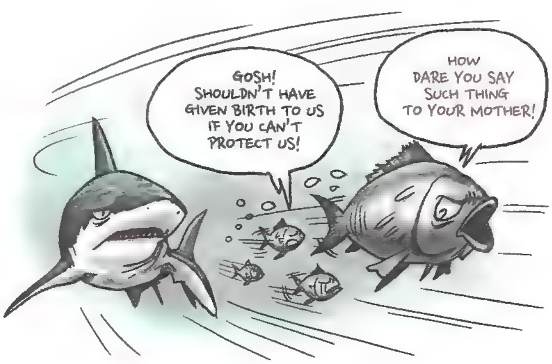


Now, the story has finally returned to its beginning. Why did life forms have no choice but to go on land despite all these reasons?



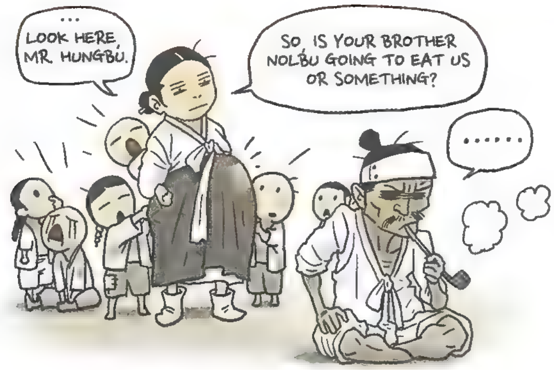
Truth be told, the first ever to go on land wasn't the vertebrates, but an arthropod, their natural enemy. Their position as natural enemy is reversed later on. The sow bug inside the red circle is something of a future descendant of the 'Brontoscorpio.'

It is closely related to the issue of 'offspring reproduction.' The problem was that the 'parents,' who needed to protect their young from predators due to their better survival skills, were themselves 'prey.'

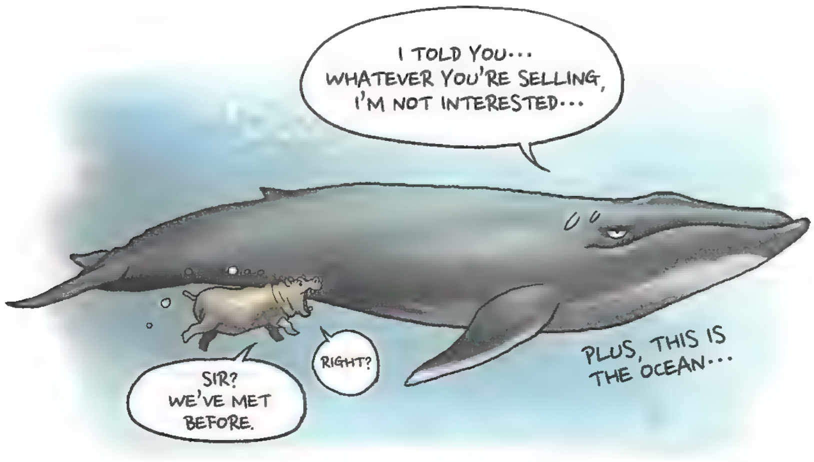


That is why many life forms that have a duty to preserve their species probably have thought about how to increase the survival chance for their offspring from predators or from natural enemies. In this case, there are two possible solutions.

❶ Give birth at a location where predators cannot reach easily
❷ Give birth to many offspring



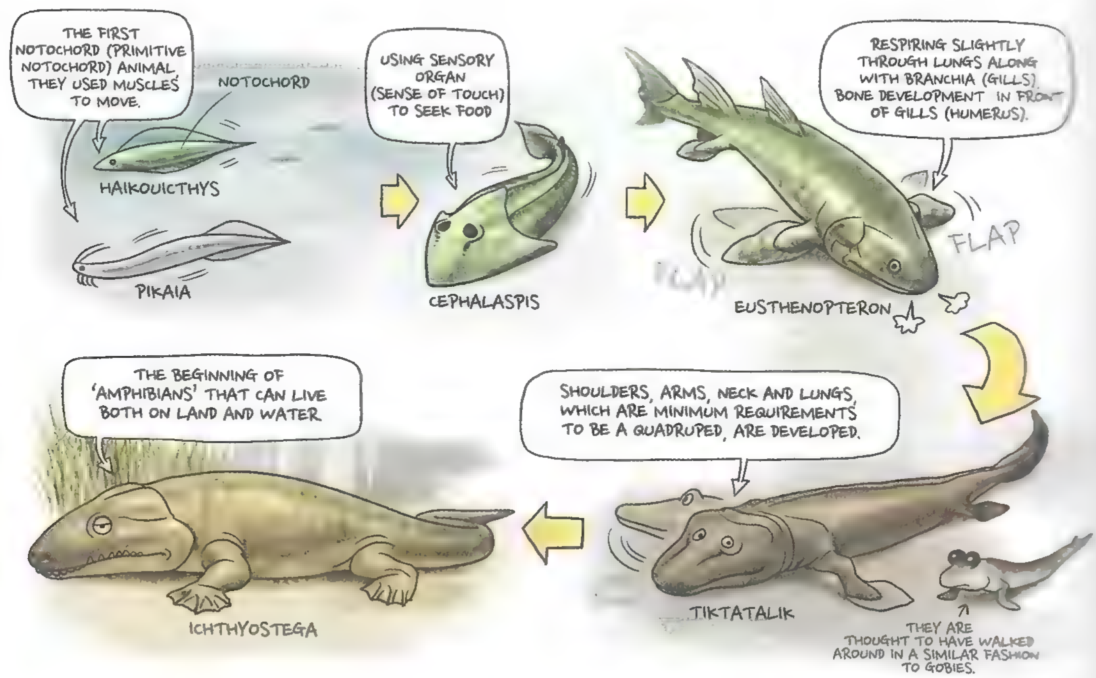
The ancestor of us vertebrates decided to go with the first solution.
Of course, while there were predators that came ashore following the prey parents who came ashore to give birth, the land was still an effective strategy to increase their number compared to giving birth in the ocean where there are a lot more predators.
Of course, there were mammals (whales) that returned to the ocean for their survival. Whether it was the past or the present, the desire to survive is as desperate as ever for every living creature.



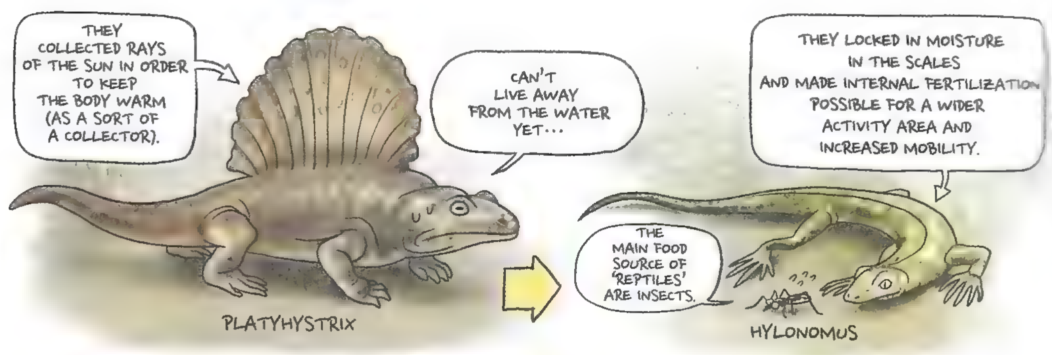
Based on evolutionary taxonomy, whales are classified as being related to 'ungulates' such as the hippopotamus or pigs.

Coming Ashore, and What Happened Next

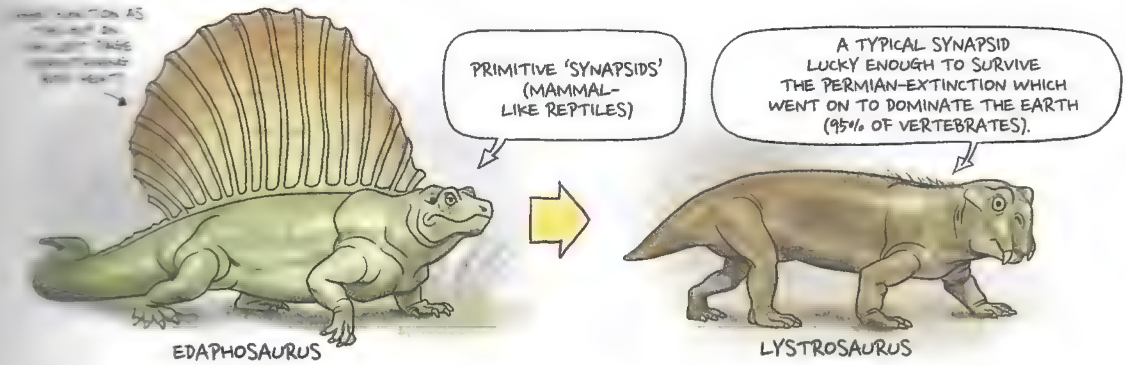
Vertebrates, our direct ancestors, succeeded after many hardships in coming ashore, and then needed to change their physiology in order to adapt to land life. First of all, they had to harden the pillar in their bodies in order to support the weight (notochord -> spinal column), and they had to move the bones on their fin inside their body to change them to 'legs.' It was around that time they had to change their gills into a 'lung,' an organ to filter in oxygen in the air for breathing.



Amphibians still needed to live close by water even though they could live on both land and water. In order to expand their territory, they needed to develop 'scales' to maintain moisture in their skin and strengthen the function of their heart to carry oxygen in their body in order to move quickly.

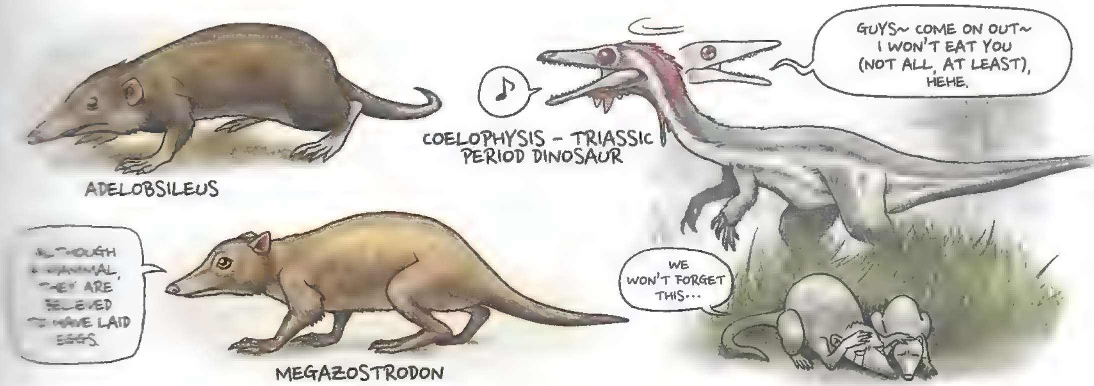


The early reptiles that adapted to land life were once again divided into predators and prey. However, a large scale diastrophism isolated them in the middle of Pangea and have evolved into the appearances, and behaviors of the mammals we see today.



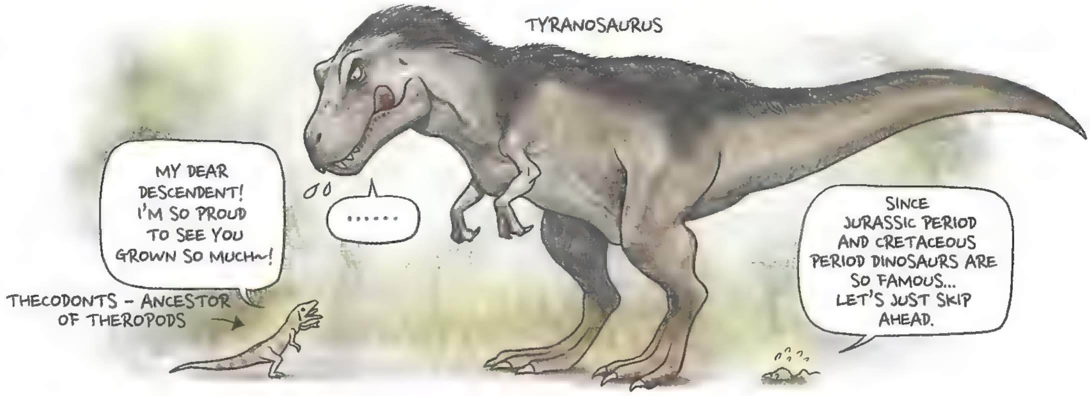
When you examine the skull of a synapsid, there is an arch-like bone (the beginning of zygomatic arch) developed under the big holes (temporal fenestrae) in the back of the eye sockets, thus earning them the name 'synapsids.' They later evolved into 'therapsida,' becoming closer to mammals.

Meanwhile, approximately 230 million years ago a group of animals with smaller bodies that used 'feathers' to maintain their body heat appeared. They were the very first mammals and appeared almost at the same time as the giant reptiles, the dinosaurs. From that point on, the reptiles and mammals start their long years of competition, and evolution.

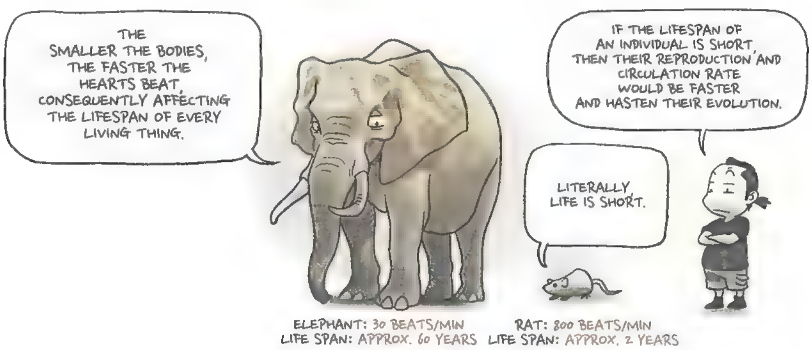


The behavior of the first mammals laying eggs can be found on spiny anteaters and platypus, etc. They were active at night, away from the eyes of the predators.

After the 'Triassic Period,' was the time for the 'Jurassic Period,' which we are familiar with from the movies and the 'Cretaceous Period.' Since then, dinosaurs were the ruler of Earth for 100 million years.

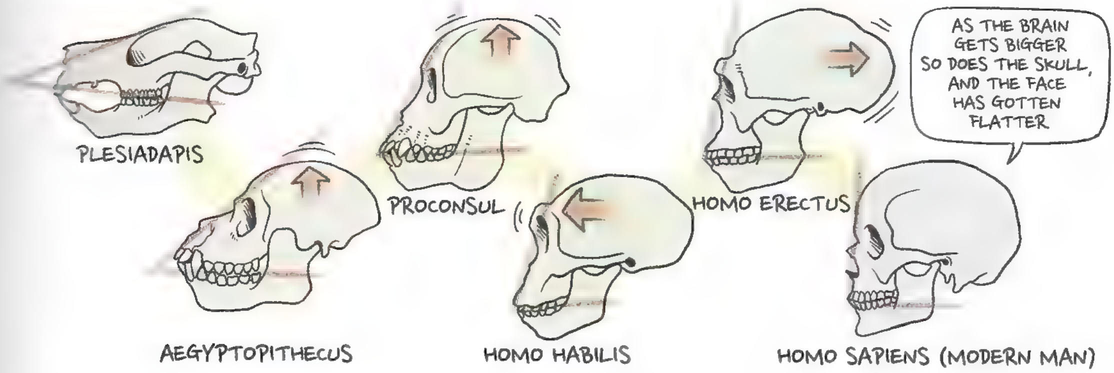


Then were our mammal ancestors just playing around? As if. While the dinosaurs were enjoying their prosperity until the meteor hit the Earth, and the Ice Age started, our ancestors went through evolution after evolution to prepare for their time of prosperity.



After the long Ice Age and the dinosaurs' reign ended, mammals that were relatively adept at maintaining their body heat took over, and then divided into many different species, with different variations. As the number of species and their individual numbers grew, there were ones that moved to the safer trees to get away from the dangerous land, like their ancestors that decided to move to the land from the ocean. This started the was the emergence of primates which are the direct ancestors of humans.

A common trait of primates was traveling from tree to tree and feeding on fruits and insects. This caused the development of depth perception and hand function. As a result their brains grew bigger, and here we are today.



Humans are one of the animals on Earth with the highest brain-to-body weight ratio. Development of the brain and its capacity due to using hands and tools and standing erect greatly affected the appearance of mankind. (Note that the example above is a comprehensive inclination. There were many different species of mankind as well.)

We have reviewed a very brief evolutionary history of vertebrates which we are a part of, but there are still diverse opinions on evolution, and new findings are coming up every day. It is true that it's hard to come to a conclusion on anything. One thing remains true now, and in the past, that every living creature has put in enormous effort to adapt to the environment, and humans are merely a part of it.

I believe that our bodies are no different from an encyclopedia that contains every bit of our history of desperate struggle for survival. Knowing that, exploring the human anatomy won't sound too strange anymore, right?

'Art Market' / Painter pencil brushes / 2007

II

Basics of the Body

Let's learn about the bones and muscles; the basic elements that constitute our body.

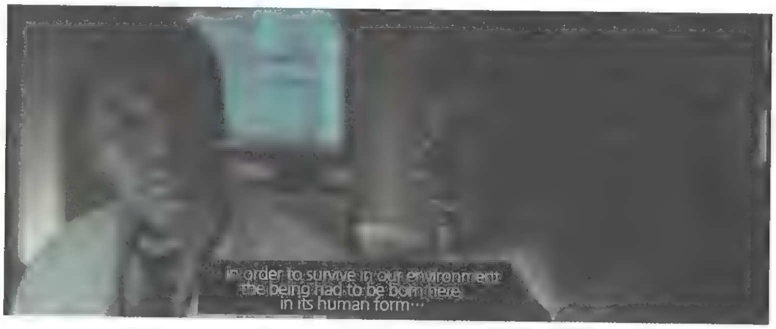
The reason why many organs are in their place and that we can maintain the functions and the appearance of our body structure is because of the 'frame' in the center.
It is true that our bone structure is complicated,
given the fact their role is important and complex.

There may not be a rule about the shape of our bones, but there are principles.
There must be a reason why our bones look the way they do.
When we understand the reason, we will be able to understand the complex form of the bones relatively easily.
We can then also understand the appearance of the muscles attached to those bones.

Let's first identify the basic points of the bones and the muscles.

Earth = Earthling?

There is a movie called. 'The Day the Earth Stood Still', starring Keanu Reeves. In the story, Keanu Reeves' character is portrayed to have a body that is surprisingly very close to that of a human's anatomy despite the fact that he is an alien, and an astrobiologist 'Dr. Helen Benson' (Jennifer Connelly) explains as below.



Astrobiologist 'Dr. Helen Benson
(Jennifer Connelly)' in The Day the Earth Stood Still.)'

'The being had to be born here, in its human form.'

This short line, which sounds like a poor excuse to save costs on the alien costume and make up, provides a big clue to understanding the 'human body' we are about to explore. It is not incorrect even though it is fiction. The story is about having to be born into a human body in order to survive in Earth's environment, in other words, a body that is optimized to survive in this special environment called Earth.

In the grand scheme of things, the human body had to be in this form to adapt to the Earth's environment; on a smaller scale, to efficiently survive against other life forms.

may sound like a broken record, but to understand why the human body had to be in this form is the step to illustrating a more realistic human figure. There is a world of difference between knowing understanding the fundamentals to illustrate, versus not knowing and just copying.

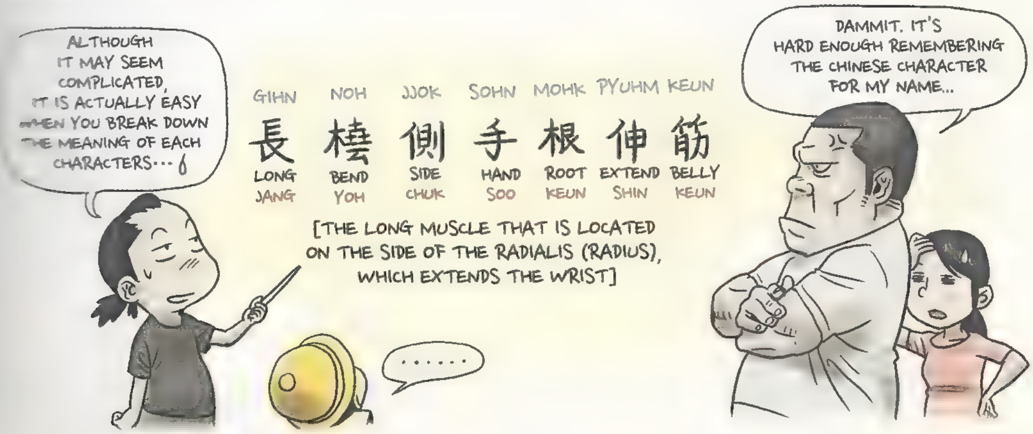
then, shall we explore the 'bones' in detail first, as it is the basic foundation of the human body?

WAIT! Korean Names, Chinese Writing

Before we get to the main point, I must point out that although I use 'Korean names' for the anatomical terms, I will write them in 'Chinese characters.'

The terminologies we are familiar with, from 'skull, biceps, pubic bones, etc.' to terminologies like 'the thorax, muscle flexor carpi radialis, ligament inguiunale, etc.,' are mostly from the Japanese kanji (in medical school they usually use English terminology). It would be the right thing to use Korean terminologies. However, Chinese characters have been used for a very long time, and the anatomy books that are currently being sold in the market mostly use Japanese kanji.

On the other hand, it is very helpful to understand the meaning of the Chinese characters when studying anatomy for art. This is the character's meaning will help describe the form, location and the function of the said body parts.



Of course, I will use 'English terminologies' as well, but please note that I will mainly be using 'Korean + Chinese characters.'

The Human Bones

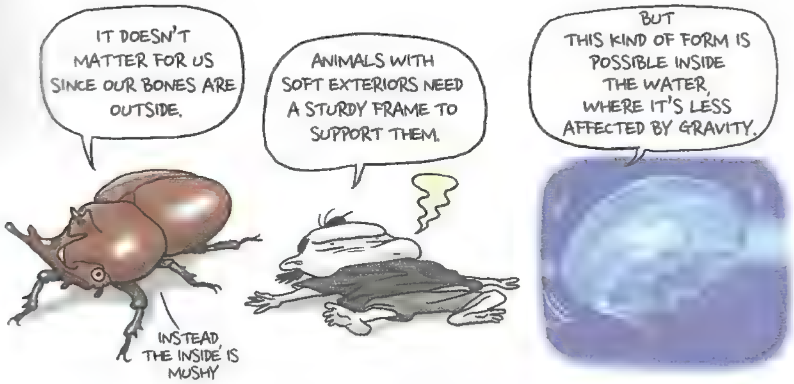
The Rugged Bones

As we all know, the bones (skeleton) are the most basic foundation among the many elements that constitute a body. It is such a familiar form that even people with no interest in anatomy can easily conjure it in their minds.

The Rugged Bones / Painter 10 / 2010

... are a physiologically important structure because it contains minerals (calcium, phosphorus, ...) that are essential to bodily activities such as metabolism and neural signals. Even 'blood' is ... bones.

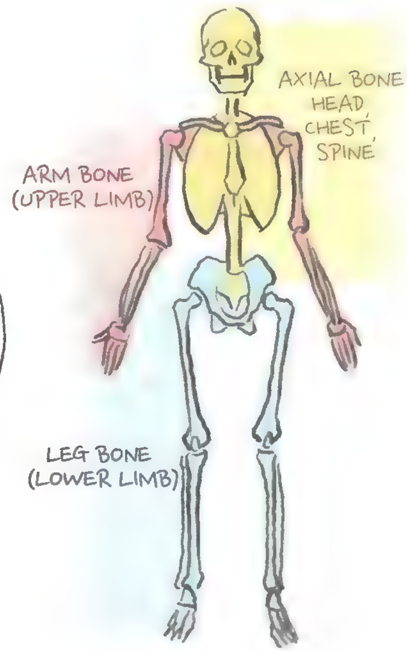
... the most important role of the bones is to maintain the posture, that is, to 'support.' ... effect on earth, it would be impossible to maintain one's form, let alone move at one's ... bones.



Personally, I put 'bones' in much higher regards to 'muscles' when I'm drawing a person. While the muscles are obviously connected to the 'bones' as a basis, so are the skin, hair, chest, etc., making the bones a very important concept for someone who is studying art. If you think about how nouns such as 'frame' or 'framework' are commonly used, you can see their importance even if you don't ...

Axial skeleton - skull, ribs, sternum, spinal column

Appendicular skeleton - arm bones, leg bones, clavicle, shoulder blade, hip bone



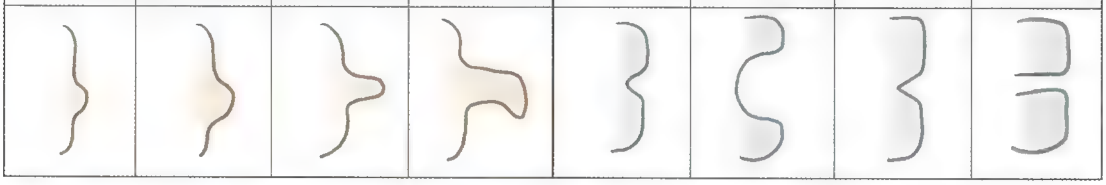
Even from a medical point of view, not having appendicular bones such as arms and legs is inconvenient in a functional sense, but it won't have big effect on preserving a life.

In the past, when Koreans used Chinese characters for axial skeleton, they used the characters 'body, root, and bone' which meant 'bone that is the stem of the body.' For the appendicular skeleton, they used the character for 'parts' which literally meant 'bone that is attached to the body.' They also used different characters at times but they meant the same thing.

Simply put, the axial skeleton plays a crucial role as a protective barrier for the important organs that are essential for humans to live. While the appendicular skeleton plays the role of locomotive organ to support the axial skeleton. So basically, the arms and the legs must be able to move well structurally, to be able to support the body safely. I will explain again later, but this is a very important basis for drawing anatomy.

There is an average of 206 bones in adults whereas infants have 350, but they combine and shrink in numbers as they grow older. Each bone has an organic relationship with other organs such as muscles and blood vessels, so their shapes are determined by their role with certain areas that stick out or cave in. Those are called protrusions and cavities of the bones.

PROTRUSIONS				CAVITIES			
TUBERCLE	EMINENCE	PROCESS	SPINE	FURROW	FOSSA	INCISURA	FORAMEN



Usually, a protrusion means it is holding onto something (muscles), and a cavity is often there to protect organs such as eyes or to create pathways for blood vessels, nerves, or tendons.

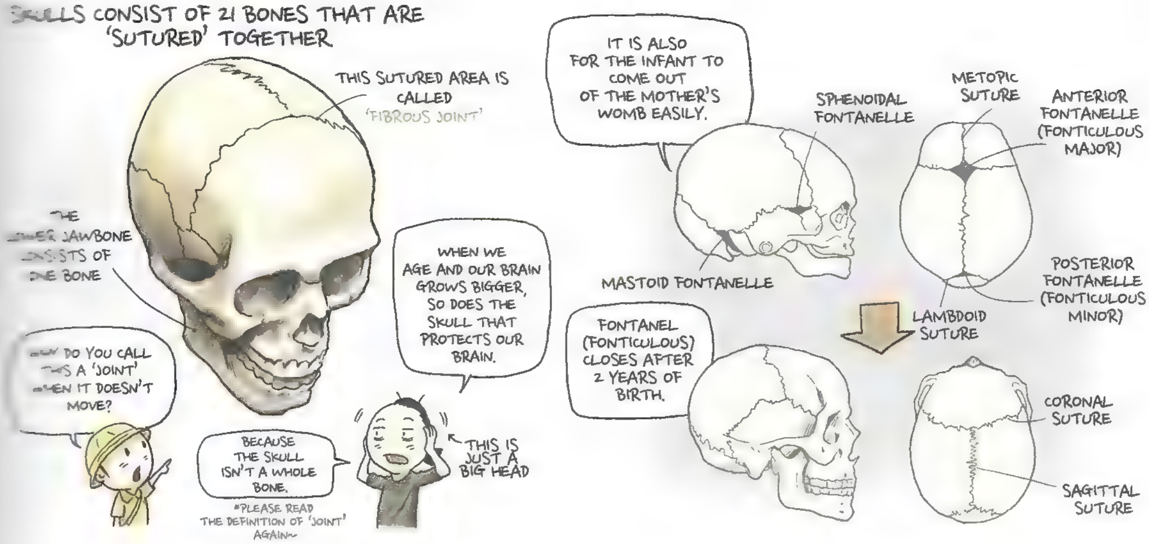
Protrusions and cavities are concepts that will continuously appear on of bones of our body during our study of anatomy. It will be much easier to study them if you understand the physical characteristics of each protrusion and cavity. Please pay close attention to them.

■Bend the Joints

In one sentence, a joint is an area where two bones meet.
Typically, we think joints only refer to moving parts like wrists or ankles, but that is only one type of joint. There are many different types of joints. and which type depends on the shapes and functions of the bones. They can be divided into three big groups of joints based on the 'materials' that connect the bones.

Fibrous Joints

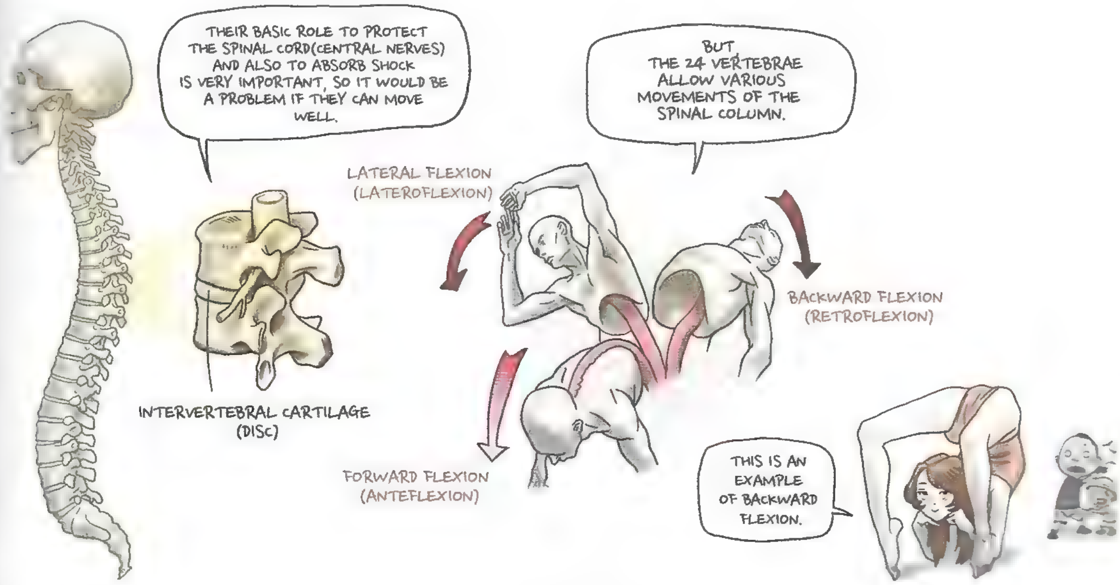
Fibrous joints are connected firmly by durable fiber, it's as if they are glued together. The sutures on a skull are a typical example of a fibrous joint.



There are soft membranous gaps in between the cranial bones of the skull during infancy so that their skull can grow according to the growth of their brain, and they are called fontanelles.

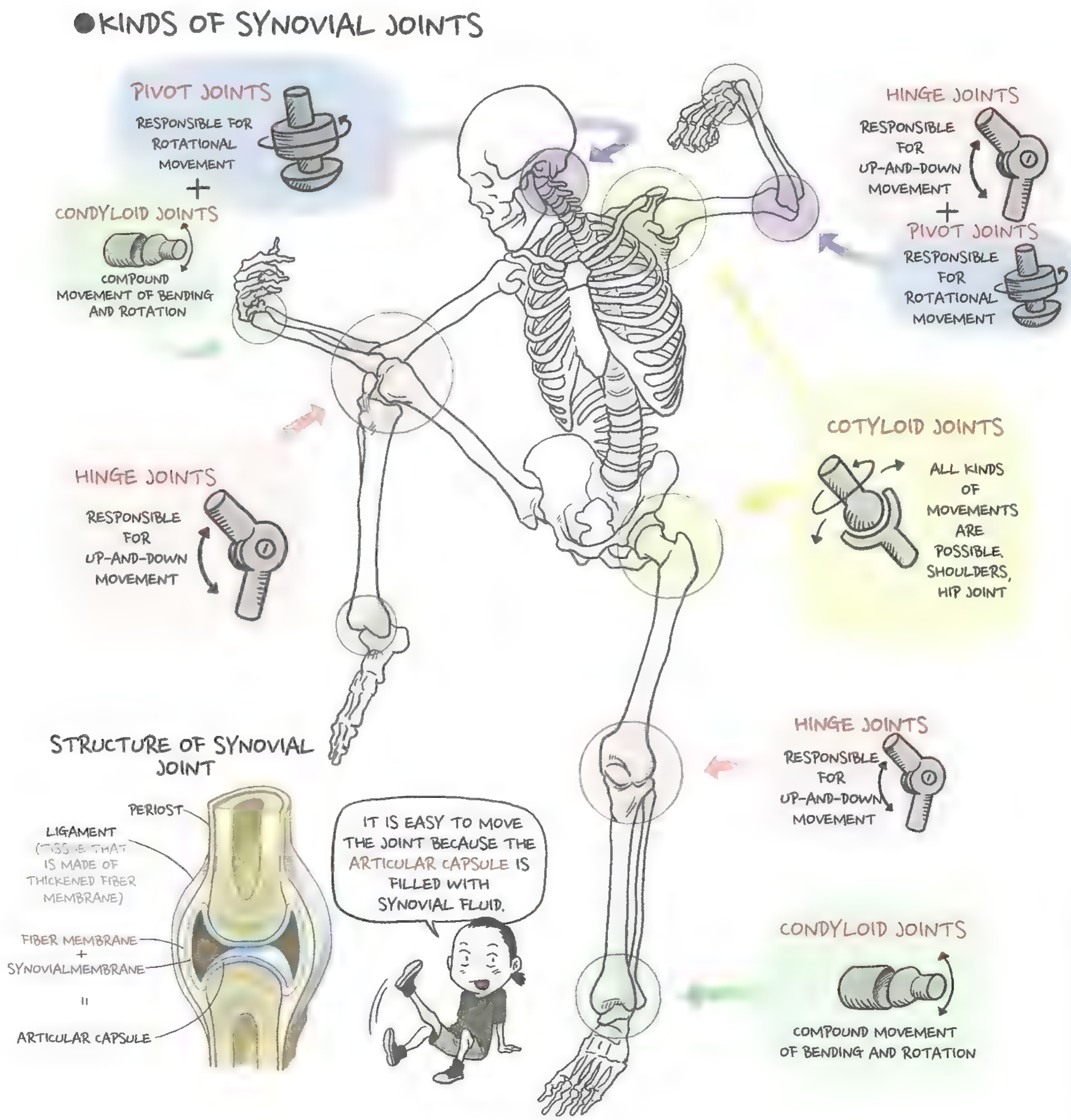
Cartilage Joints

This literally means joints that are connected by cartilage. They can move a bit individually, although not much, but 'big movement' is possible when they move as a whole. 'Intervertebral cartilage,' is also known as a 'disc,' is a typical example.



❸ Synovial Joints (diarthrosis)

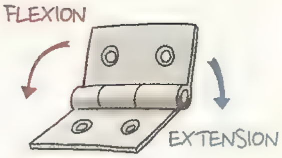
The 'joints' we commonly think of, such as elbows, knees, wrists, and ankles are what we call 'synovial joints.' The space between the bones (inside the joint) is filled with synovial fluid that allows smooth movements. Synovial joints have many different forms because they play a unique role throughout the body with their large range of movement. Please refer to the image below for an explanation of each synovial joint.



WAIT! Types of Synovial Joints

❶ Hinge joint

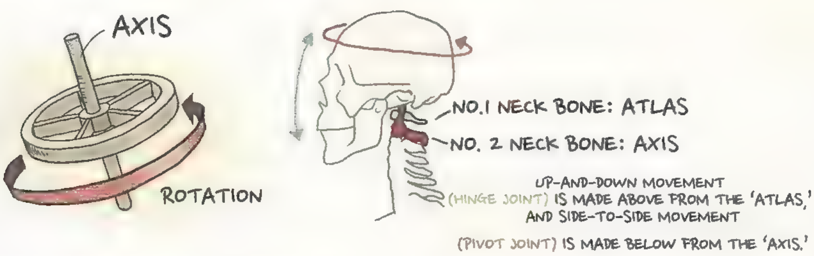
This joint is similar in structure to the hinge on a door. Its movement is only restricted to flexion and extension (up-and-down movement), and no rotation.



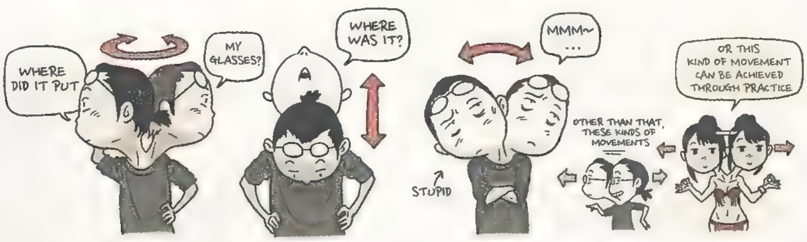
There is a 'head' on the outside of the hinge joint that prevents it from moving beyond a certain angle. Meaning, it only bends in one direction. It is categorized as a 'uniaxial joint' because it only has one axis.

❷ Pivot joint

'Pivot' means it has a central axis that allows a wheel to rotate. Our 'head' is probably the first thing that comes to mind when we think of a 'rotating' part in our body. That's right. The neck bone (no.2 neck bone: axis) that allows our head to rotate is a typical example of pivot joint. Pivot joint is part of a 'uniaxial joint,' like the hinge joint.



But the head doesn't only shake side-to-side.

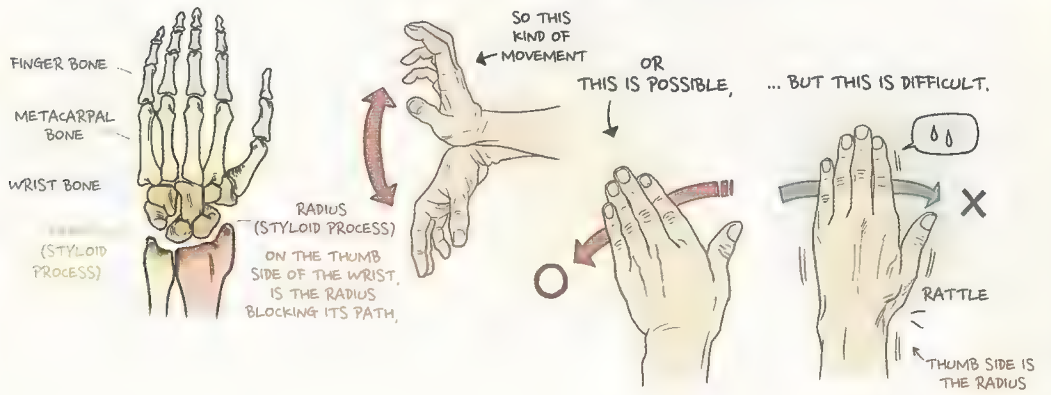


The head can make many kinds of compound movements other than the rotation, as you can see from the images above, the reason being in the 'condyloid joint' which I will be covering in the next page.

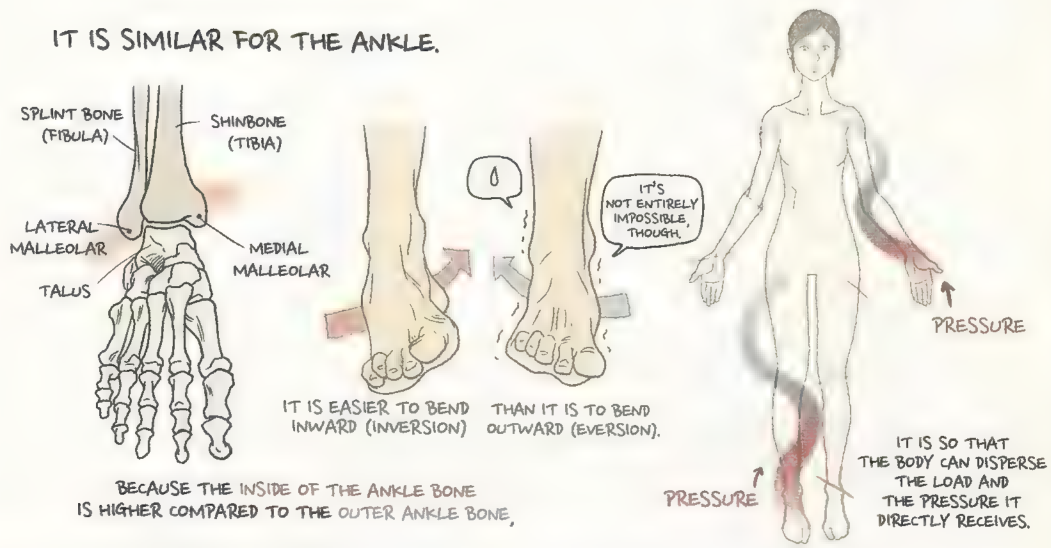
❸ Condyloid joint

The condyloid joint is a joint that has up-and-down movement along with a limited range of left-and-right movement. This movement is made by the head, as I've shown earlier, but you can also observe it in the wrist.

The condyloid joint has a flat elliptical shape, so it is good at supporting weight. Its strength is that it is capable of more varied movements compared to the 'hinge joint' and the 'pivot joint' we explored earlier. But keep in mind that its movement isn't entirely free.



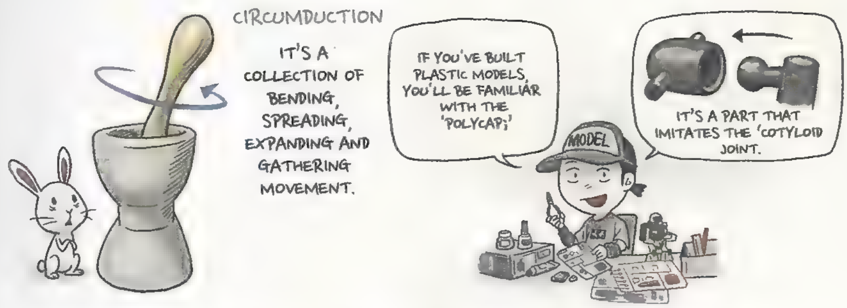
IT IS SIMILAR FOR THE ANKLE.



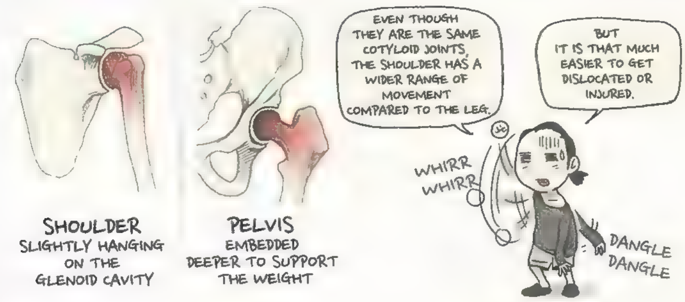
As you can see, the reason that condyloid joints of the wrist and the ankle has a limited range of motion is so that the body can gather the center of the gravity towards the inside of the body to maintain a stable posture, like a safety mechanism. Also, the condyloid joint is categorized as 'biaxial joint' because it usually has two axis points.

Cotyloid joint

The cotyloid joint literally looks like a mortar. This is the joint with the most freedom of movement out of all the joints we've reviewed.

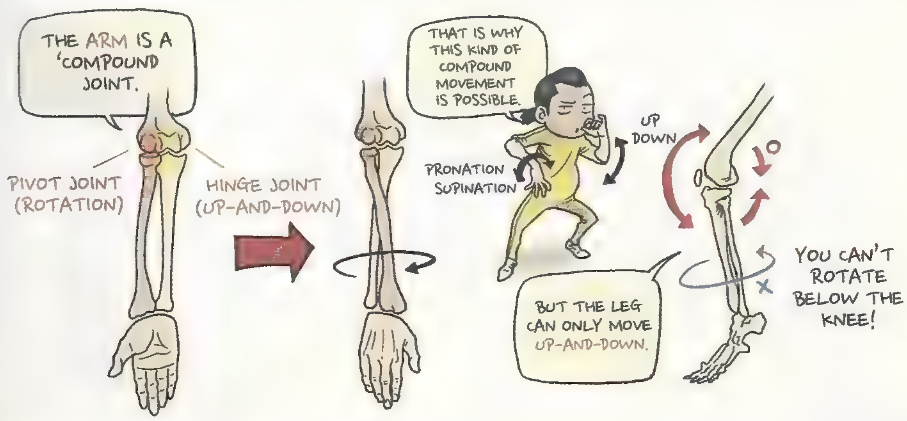


The cotyloid joint has a large range of movement compared to the uniaxial joint or bifurcation joint, and they are categorized as a 'multi-axial joint.' You can see cotyloid joints in places like the shoulder and pelvis, meaning where the arms and legs begin, and they are a little different in appearance.

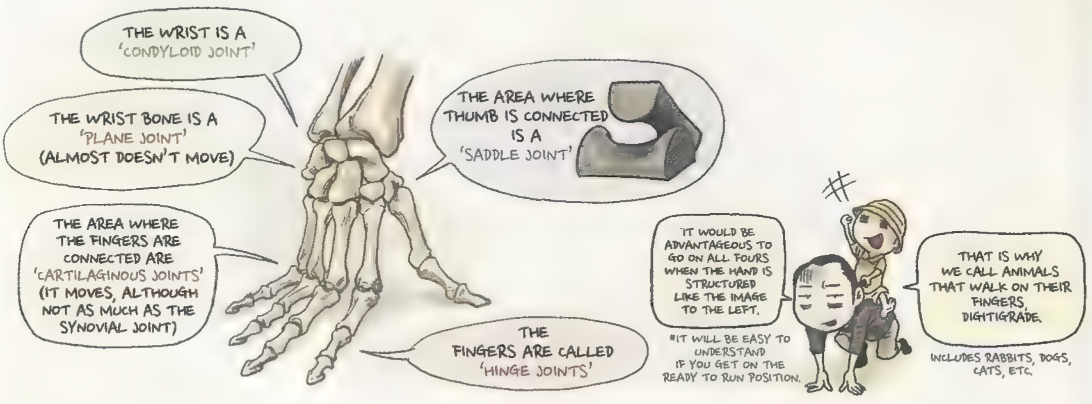


Compound joint

The 'compound joint' is a joint that consists of more than two bones, so it has a broader meaning than the 'synovial joint' (the opposing term would be 'simple joint'). Prime examples of compound joints would be the atlas and the axis which moves the head, which we covered briefly earlier, the forearm that is able to pronate and supinate, and



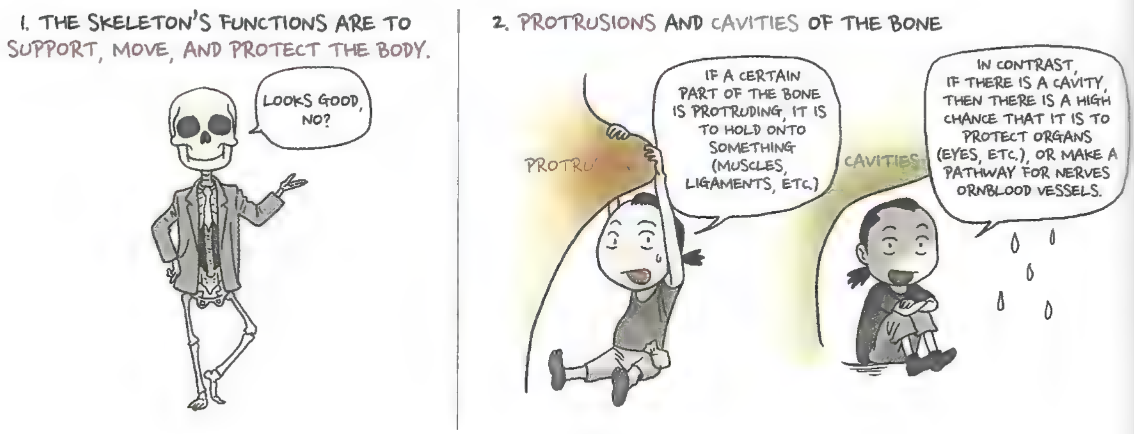
the 'hand' which is like the 'complete gift set of joints.'



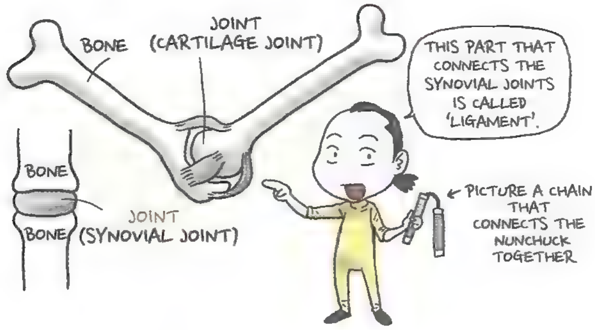
The 'saddle joint' that connects the thumb is a joint (bifurcation joint) that doesn't exist on any other finger and is exclusive to the thumb, because it oversees the rotation, bending, etc. of the thumb. The 'plane joint' that exists in between the wrist bones is a joint that only slightly slips and almost doesn't move (non-axial joint), so we will be skipping its explanation.

■Summarizing the Main Points of the Skeleton

We've covered the common points of the shape of the bones up to now, but the 'joints' by themselves are confusing, aren't they? Don't worry it's the same for me - but luckily we don't have to understand them all right now! You will have to continually review them over and over during your studies. The most important points are summarized as below:

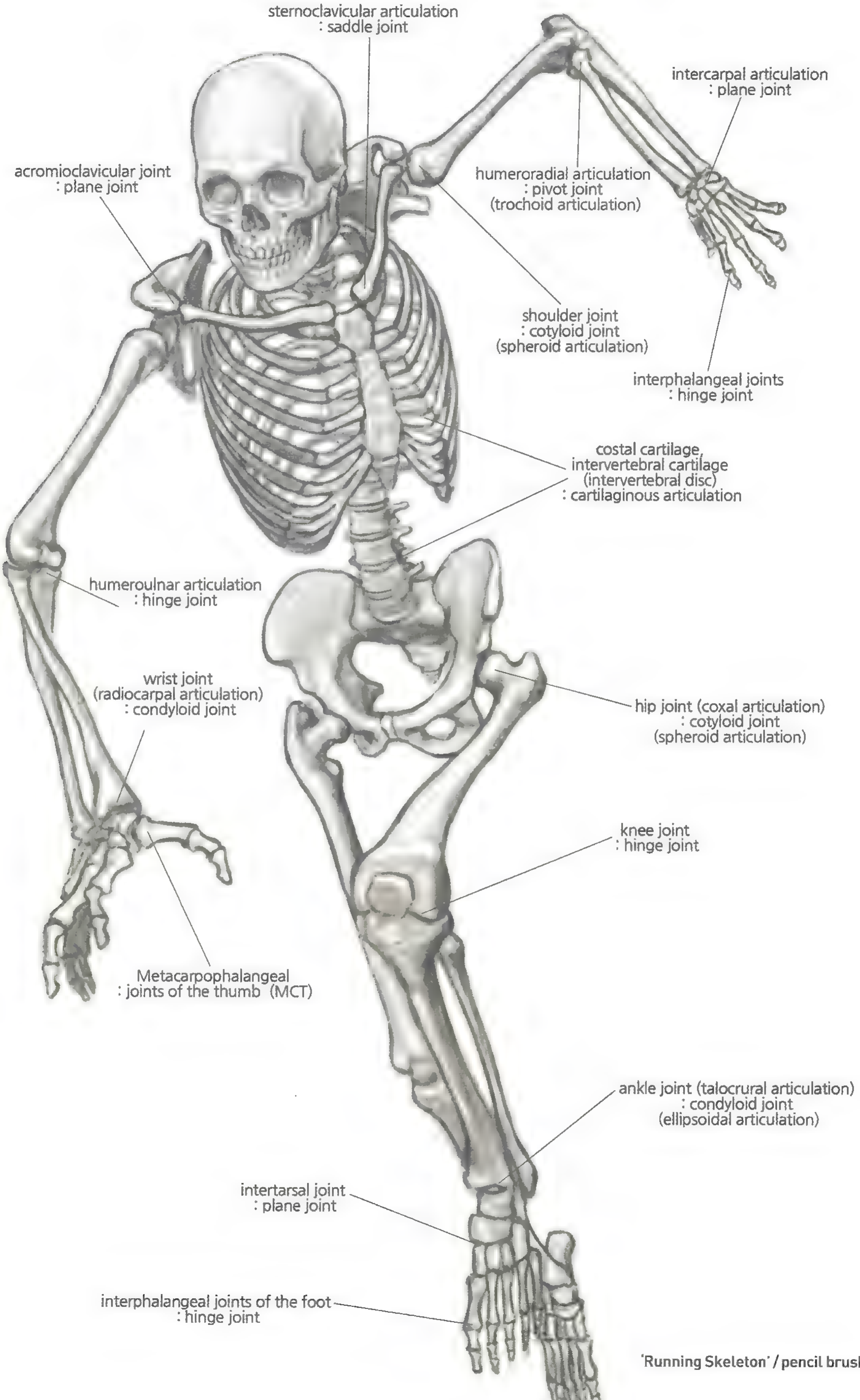


3. BETWEEN THE BONES, IS THE 'JOINT.'



Now then, with this we can say that the foundation to understanding the 'bones' is established. However, bones are very abstruse in that their shapes are hard to make out even if we study these points. That is why understanding the 'reasoning' behind their shapes is important. We can understand it if we know the reason why, and we can easily picture their shapes if we understand them. We will be exploring the reason from here on out, so let's make sure we understand the outline we've covered so far.

'Various Joints of the Skeleton' / Painter 10 / 2010



'Running Skeleton' / pencil brushes / 2016

The Function of Muscles

Did you know there are more than 650 muscles in your body? Your muscles come in different shapes and have various jobs. But ultimately, your muscles are what make your bones move. They also influence your physical appearance and play an important role in the expression of the human body. Without a doubt, muscles are the flower of anatomy art.

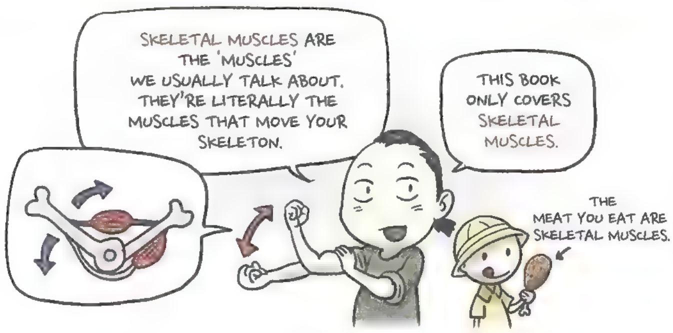
'Full Body Muscle Depiction' / Painter 10 / 2010

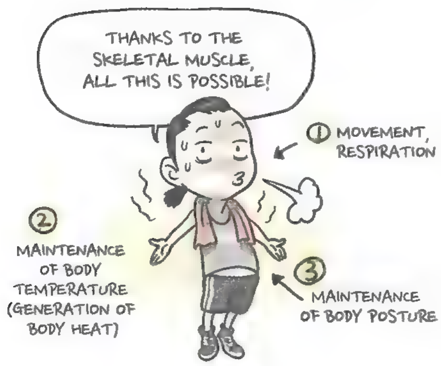
The human body has three types of muscle, each with a different job.

❶ Skeletal muscle
They are attached to the bones of the skeleton and make body movement possible. They are often called 'striated muscles' because they look striped. Skeletal muscles are 'voluntary muscles,' meaning you can control what they do. When people talk about a particular muscle, they're probably referring to a skeletal muscle.

❷ Visceral muscle
They are found in the walls of the eye, stomach, bladder, blood vessels, etc.. They are also known as 'smooth muscles' because they don't look striped like skeletal muscles. Visceral muscles are 'involuntary muscles,' meaning you can't control what they do.

❸ Cardiac muscle
They are found only in the heart and are responsible for pumping blood throughout the body. These muscles work on their own to contract and relax, from the moment you are born until your death.





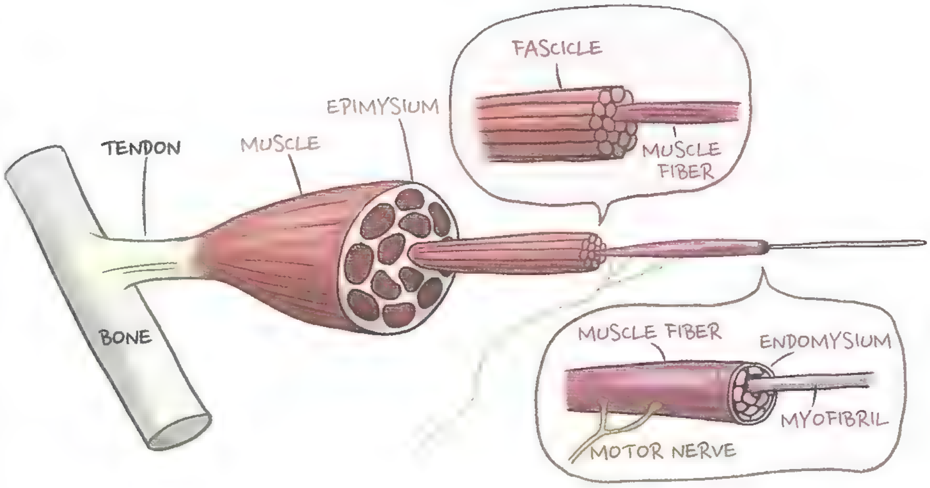
On top of making your body move, skeletal muscles make breathing possible by moving the thoracic cage(chest) that protects the heart and lungs. They control body temperature by converting energy into heat and help maintain body posture.

I also want to point out how skeletal muscles give the its body shape. Anyway, keep in mind that every 'muscle' I talk about from now on is a 'skeletal muscle.'

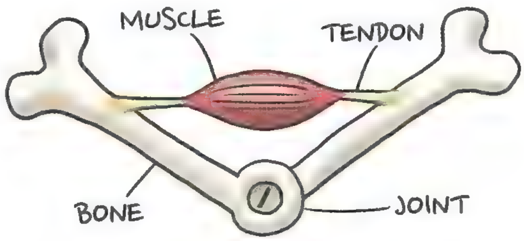
Like I said, there are more than 650 muscles in your body. It may sound like an overwhelming number of parts to study. The good news is that from an artistic perspective, things are much simpler. No matter how many muscles there are, they are merely lumps of tissue attached to bone. As long as you have a deep understanding of the skeleton, you have nothing to worry about.

The Structure of a Skeletal Muscle

This is the basic structure of a skeletal muscle.



A skeletal muscle is made up of hundreds of muscle fibers bundled together. These muscles contract when it receives a signal from its nerve. They are attached to bones by tendons, which are tough bands of fibrous tissue. In essence, muscles and tendons work together to move your body. Here's a further simplified image of a skeletal muscle.

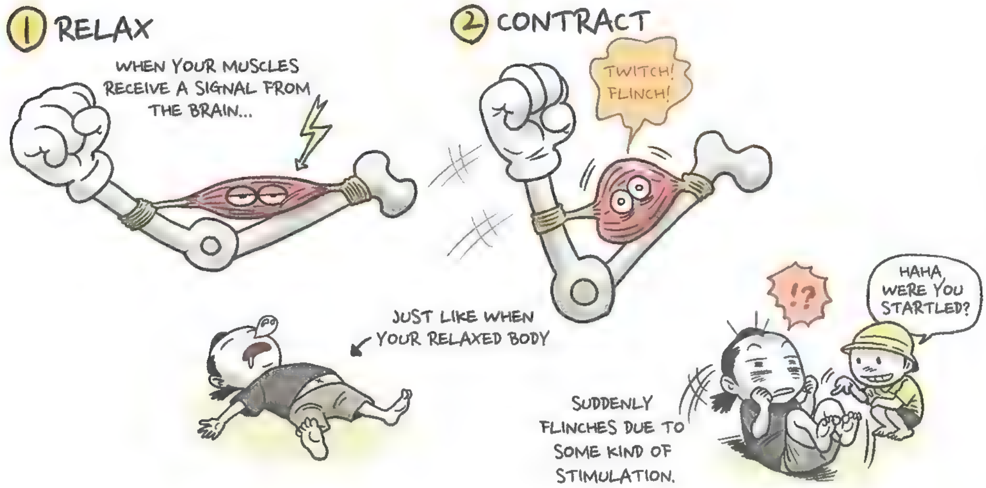


Looks simple, right? The structure itself may be simple, but skeletal muscles are found throughout your entire body. They have a big role in the study of human anatomy so it's important to have a good understanding of them before moving on.

❶ Muscle

As I mentioned earlier, muscles span a joint and are attached to bones by tendons.
Let's take a look at muscles first.

Your 'muscles' are made up of a bunch of muscle fibers. When a muscle fiber receives a signal from its nerve, your muscle contracts and pulls the bone. This simple process is what makes every movement of your body possible.



Refer to the image on the right. In response to a stimulus, all the joints in your body flex and your body automatically curls up. This is known as a 'reflex.'

Contraction is the movement of your muscles that makes your body curl up. This may sound obvious, but muscles bulge out when they contract.
The muscle may shorten, but its mass doesn't change.

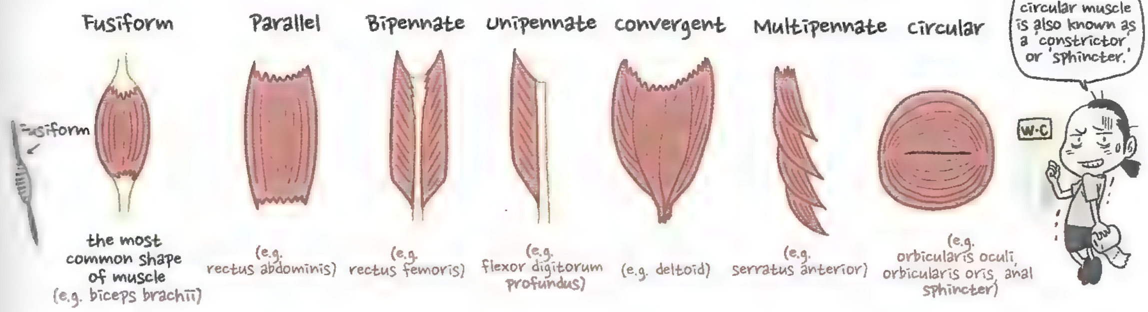
The important thing is that muscles only contract and relax. They don't expand.
Keep this in mind.

Wait! Do muscles expand or contract?

Some textbooks describe muscle contraction as an activity that 'expands' the muscle. The focus is placed on the muscle bulging out and 'expanding,' not on the 'shortening' of the muscle. Either way, the fact is that muscle mass doesn't change. Though the words 'contract' and 'expand' have opposite meanings, both are used to describe the same muscle movement. To avoid confusion, I'll be consistent and use the word 'contract' from now on.

There are numerous kinds of muscles with different shapes and functions.

Shapes of Skeletal Muscle



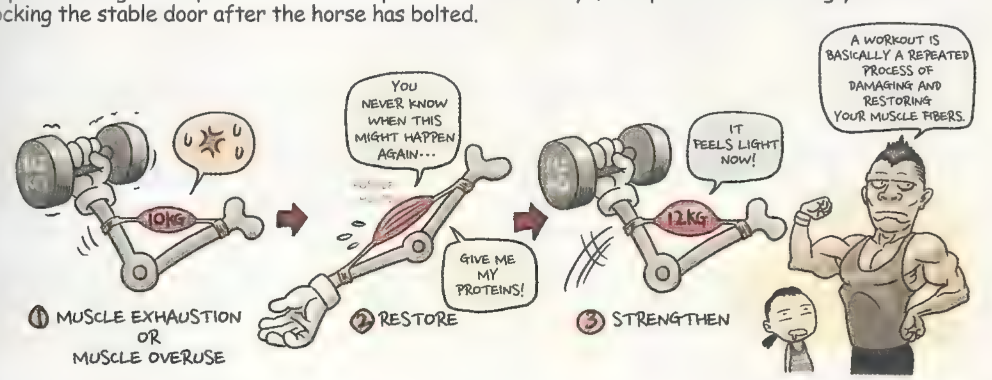
Fusiform muscles are spindle-shaped. In other words, they are wider in the middle and have tapered ends . Bipennate muscles have a row of diagonal fibers attached to both sides of central tendon, resembling a feather. As the name suggests, multipennate muscles have diagonal fibers attached to multiple central tendons, looking like an array of feathers.

Skeletal muscles come in many different names and shapes, but they serve the same purpose (to move your body by contracting). I'll be covering this in more detail later.

Wait! Do you know how muscles grow?

Remember how I said muscle contraction doesn't have an effect on muscle mass? Well, that only applies to short-term activity. Depending on factors, such as age and the amount of exercise, muscle mass can either increase or decrease.

An interesting fact is that the brain doesn't use up all of your muscular strength and saves some just in case. But if you repeatedly overuse your muscles, the muscle fibers get damaged. Your body then works to repair them, and muscle mass increases as a result of this process. To strengthen your muscles, it is important to get adequate rest and eat protein. In some ways, the process of building your muscle is like locking the stable door after the horse has bolted.

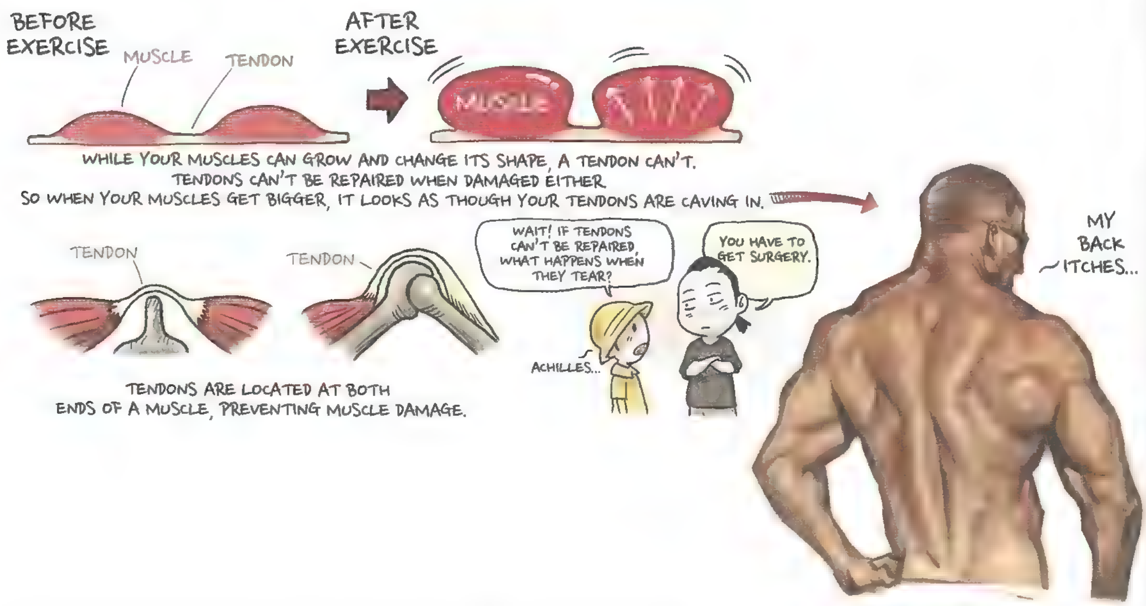


When you workout or train with weights, your body is damaging muscle fibers and actively repairing them. Bodybuilders refer to the process of building muscle as 'tearing the muscles.'

❷ Tendon

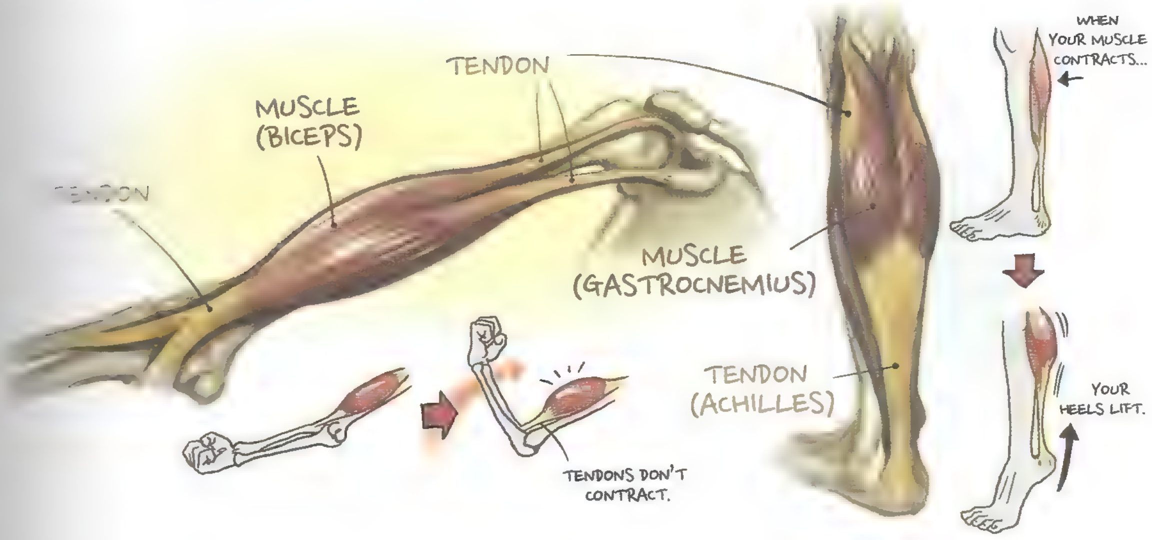
You can tell from all the images that your muscle isn't directly attached to the bone. This is because it needs to prevent your muscle from wasting energy and to better carry force from the muscle to the bone. This is where your 'tendons' come in.

A tendon, also known as a sinew, is structurally and physically different from a muscle in several ways. Let's take a look at the back muscles as an example.

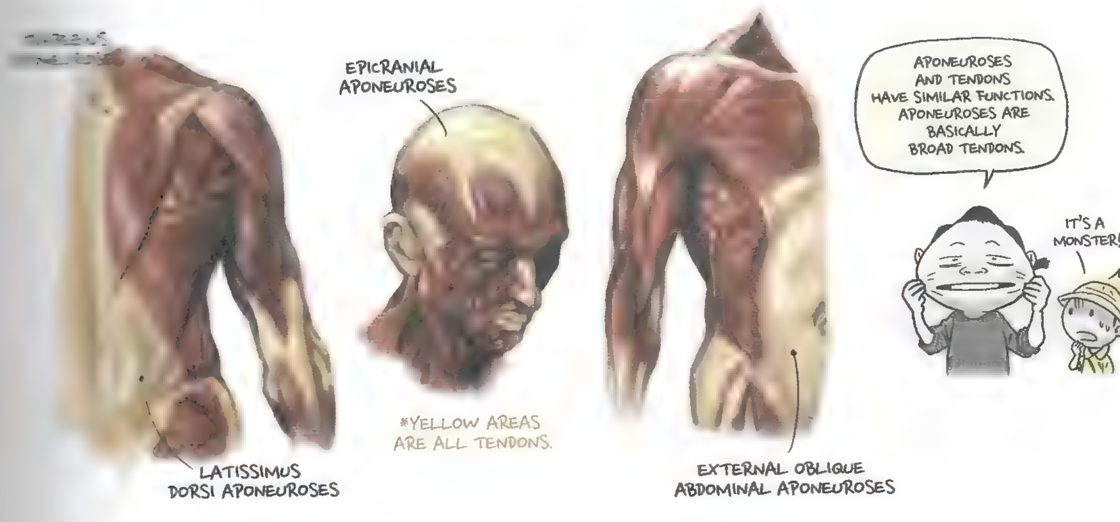


Tendons are made of tough connective tissues. They are incredibly strong and stiff. If tendons were stretchy like a rubber band, they wouldn't be able to carry force from the muscle to the bone. But unlike muscles, tendons can't be repaired once damaged.

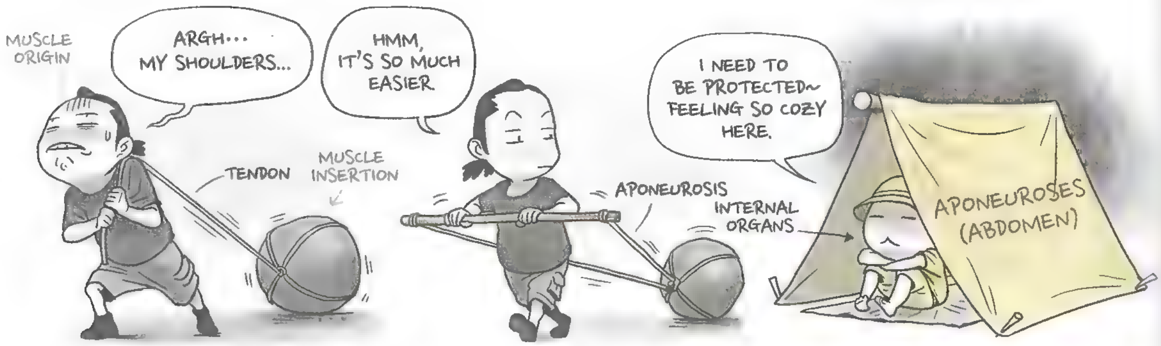
Tendons, also called sinews, are 'cords' or 'ropes' of connective tissue. They are found all throughout the body, and are especially apparent in spindle-shaped muscles like your biceps (upper arm) and gastrocnemius (calf) muscles.



Tendons connect muscles to bones. If the muscle gets broader, so does the tendon. These broad tendons are called 'aponeurosis'. They come in a variety of shapes and create unique curves in your body.



Aponeurosis are thinner than tendons. But the sheath-like structure covers a wider area, providing strength and durability. They also act as a durable layer of film that protects your organs in place of your bones. For this reason, they are usually found in boneless muscles that need extra strength and have a wide area of attachment like your abdomen and back.



When talking about our muscular system, more emphasis is usually placed on muscles than the tendons. However, from an artistic perspective, the tendons are just as important as the muscles. When muscles "bulge out," tendons "cave in." Your body is three-dimensional so it's important to pay close attention to the different kinds of tendons as well.

Wait! What's the difference between tendons, blood vessels, and ligaments?

● A MISCONCEPTION ABOUT TENDONS

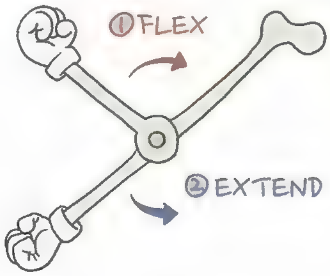
The blood vessels popping out on the man's arm are called 'veins.' They return deoxygenated blood to the heart. Following intense exercise, the amount of muscle mass increases and body fat decreases. As a result, the veins are

pushed towards the skin's surface and become visible (arteries are rarely visible). Strong muscle contraction makes the veins bulge out even more. This condition known as vascularity is often regarded as a sign of masculinity. Keep in mind, blood veins need to be placed accurately when drawing the male body. I'll explain in more detail later. (See p.623)

Ligaments are also often mistaken for tendons. They are both made of fibrous connective tissue, but they are structurally very different. Tendons attach muscle to bone and ligaments attach bone to bone. A prime example is the cruciate ligament, which holds the knee in place by aligning the thigh bone and shin bone. Also, ligaments aren't easily visible from the outside so you can just keep this information as common knowledge.

■ Flexors and Extensors

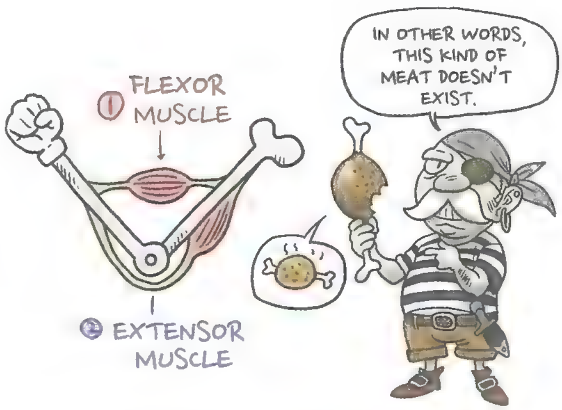
I mentioned earlier that skeletal muscles contract when stimulated. If so, how do muscles contract to move your hinge joint? It's pretty simple.



They either flex or extend. Since I mentioned earlier that muscles only contract, that means bending a joint isn't a problem. But how would you straighten it out again?

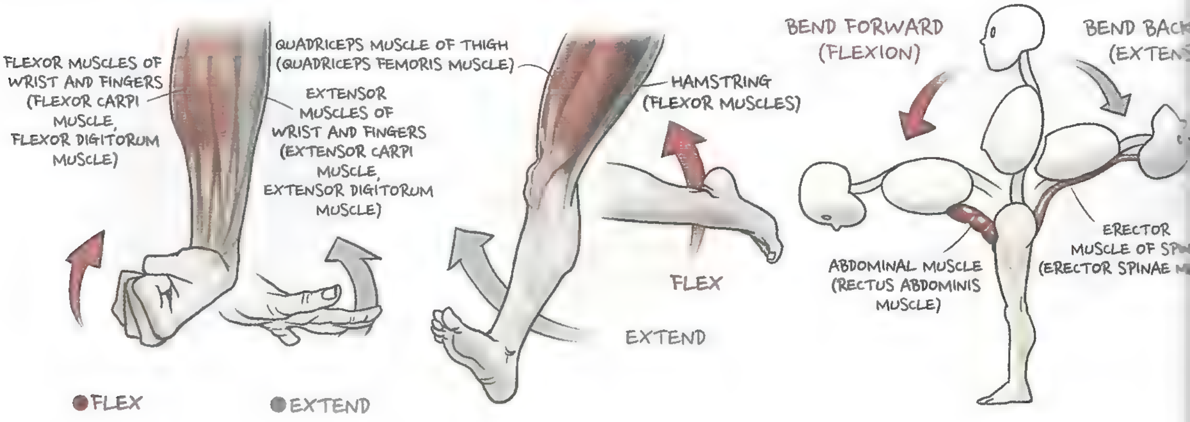
Well, that's why skeletal muscles are attached to bones that meet at a joint and work in pairs. The 1. flexor muscle works to bends a joint. Then, the 2. extensor muscle works to straighten it.

Of course, there are exceptions like your facial muscles and sphincters. But for the most part, muscles coordinate in this way.

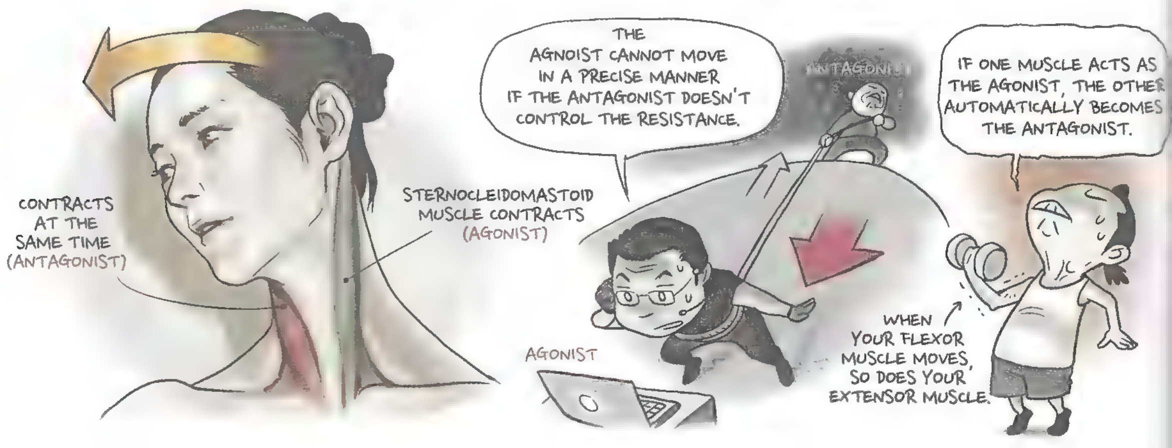


Skeletal muscles exist between bones. So unfortunately, the stereotypical meat-with-handles you saw in cartoons as a child doesn't exist in real life. Anything similar to it would actually be more like short rib patties, where the meat is minced and pounded on the bone. It could also be an intercostal muscle (See p.235

Flexors and extensors are primarily found in the body parts that perform the most important movements, your hands and feet. But it's safe to assume that flexors and extensors work in opposition throughout your whole body. If it weren't for these muscles, your body would have a hard time returning to its original position after making a movement.
Flexors and extensors will be covered in more detail later (p.303).



The pair of flexor and extensor muscles work in opposition. The main muscle producing an action is called the prime mover or 'agonist.' The muscle opposing that action is called an 'antagonist.' Keep in mind that agonist and antagonist aren't names of specific muscles, but are terms to describe how certain muscles work.

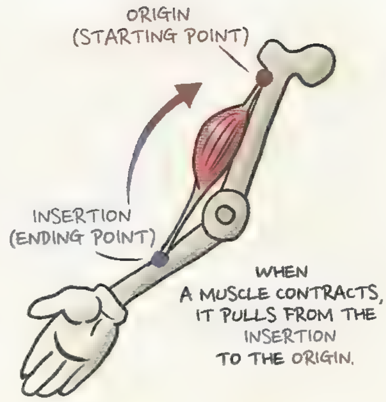


Your muscles coordinate in this way to make precise movements possible, like writing or drawing When the agonist contracts, the antagonist relaxes the muscle with careful control, allowing you to move gracefully. If antagonists didn't exist, even a simple movement like turning your neck would cause a fatal injury.

Wait! Muscle Origin and Insertion

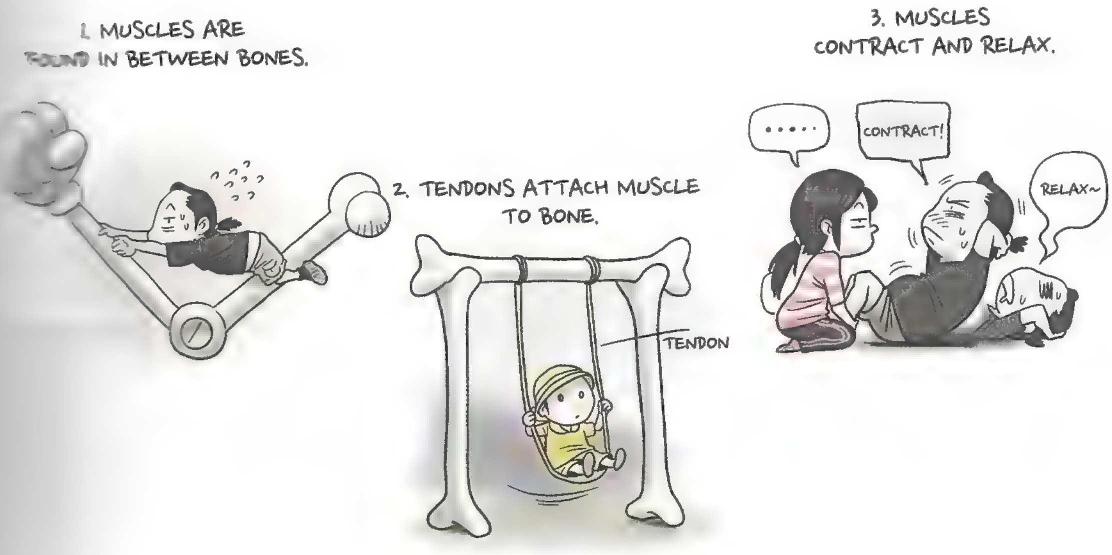
In most cases, when your muscle contracts, it pulls from the ending point of the muscle (insertion : distal) to the starting point (origin : proximal). If you know the origin and insertion of a particular muscle, you'd probably be able to guess the resulting movement of contraction.

Still having trouble differentiating the two points? Just remember that the 'origin' is the point that doesn't move during contraction, and the 'insertion' is the point that moves.



Recap of the Muscular System

We covered the basics of the muscular system. If you're still confused, just remember these three points.



I'm not an expert, but I'd say knowing these three points is more than enough in anatomy art. Each muscle will be covered in more detail when we draw them.

"Portrait of a Beautiful Woman"/ Painter pencil brushes / 2008

III
Head

Finding the Roots of the Human Body

'Roots' are the nutrient-absorbing part of a plant that is usually underground.

That's why most of us think of the organs at the bottom when we hear the word 'roots.'
But for humans, the head at the top is considered the roots.
Why?
Let's find out as we look into the different parts of the head.

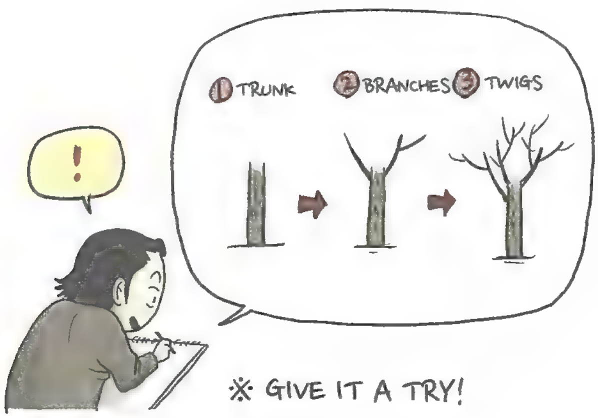
Our Head, Our Roots

■How to Draw a Tree

I have a memory of a late spring day in elementary school, when my class went out to a hillside nearby for a sketch session. I was quite excited because I packed a gimbap and it felt like a picnic. But then I looked around to start my sketch and started to be flustered. Why?

Because trees were everywhere and they were hard to draw. Just thinking about all the leaves and branches gave me a headache. As an elementary school student, the thought of having to draw each and every detail was overwhelming.

Years later when I chose the arts as my career, I still couldn't figure it out. Well, I knew I couldn't avoid the problem forever. So, I started thinking about simplified ways to draw a complicated tree. Finally, I found the solution, one that was ironically too easy. It was to draw the tree trunk first.



Leaves are attached to small twigs, small twigs extend from branches, which extend from the trunk… I came to the realization that the leaves, twigs, and branches were extensions of the tree's trunk. All I had to do was draw the trunk first and draw my way up. It was still complicated, but much easier than before.

The reason why I'm talking about trees, instead of talking about human body, is because drawing human body is just the same as drawing trees.

In other words, it gets easier when you first understand the 'branches' of human body. The arms and legs may seem complicated at a glance, but they are just branches stemming from the trunk called 'the spinal column.'

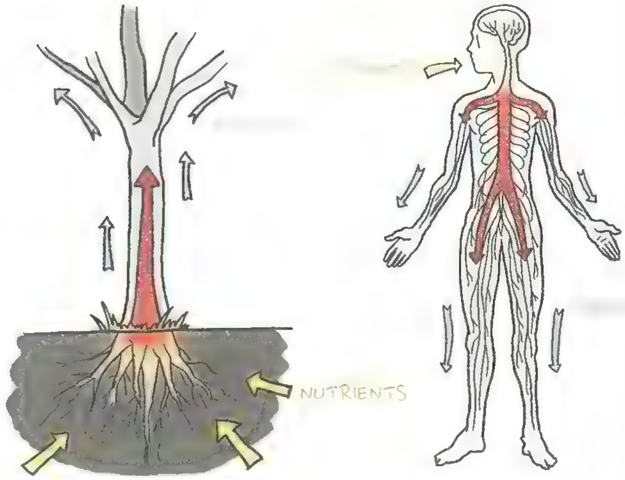
It's just a matter of thinking. If you think it'll be hard, it will be; if you think it'll be easy, it will be. There's never an end to learning so don't complicate things. All you have to remember right now is that the human body resembles a tree.

■Our Head, Our Roots

Do you know where the trunk, or stem, of a tree starts?
The answer may seem obvious, but it starts from the roots.
Then which body part is the root of your body?
Would you guess the feet?

I mentioned earlier that the human body resembles a tree, But there is a key difference. Your spine is like the 'trunk' of the tree, but the 'roots' of your spine aren't at the bottom. They start at the top of your body, your head.

Most plants, such as trees, get nutrients from roots in the soil. Animals, on the other hand, have to eat nutrients through their mouths. This is why the head, which acts as the 'roots,' is at the top.



Let's take a look at the head, which acts as the roots of the body.

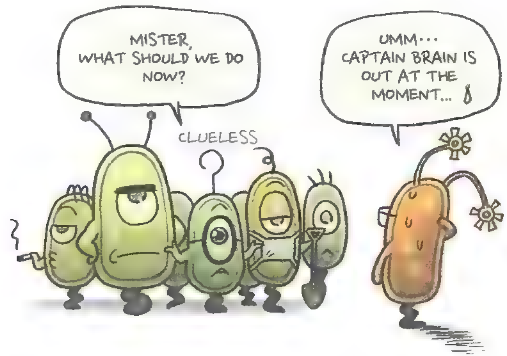
Earlier, I mentioned that the most basic instinct of all living things is to survive.

The key to survival is to actively protect yourself from outside elements or potential threats.

You'd need a control center that quickly recognizes and responds to a threat.

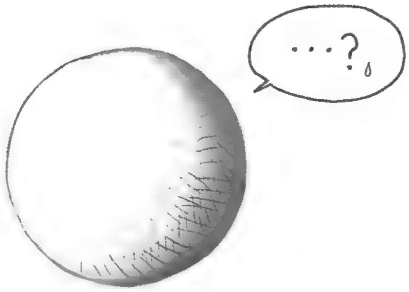
Our body's control center is the brain.

In fact, your brain is the boss of your body, controlling almost everything you do. All the other organs in your body would be meaningless without a brain to control them. Your brain is what gives you life.



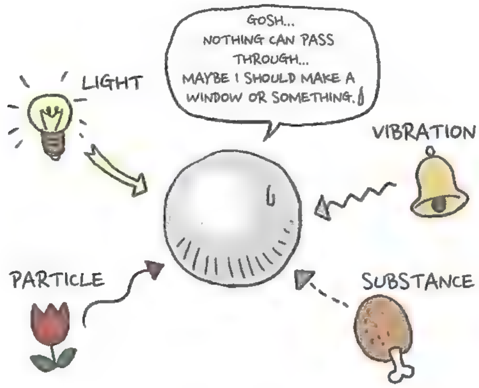
As the saying goes, 'Little wit in the head makes much work for the feet.' Without a brain, your organs won't be able to function properly.

Therefore, the best way to keep your brain safe would be to enclose it in a sphere, previously mentioned in the book as the most efficient shape for protecting life.



But... if that was the case, your brain wouldn't be able to do anything. It'll literally be 'locked up'.

Your brain needs a 'window' that allows information to pass through so that it can make decisions about a particular situation.



Your brain responds to a situation after analyzing messages it receives from all parts of your body. The organs that act as 'messengers' need to be located very close to the brain so that they can send messages quickly.

This is a spaceship control room you typically see in animations. The captain, who acts as the brain, sits close to his crew members so that he can make commands and respond quickly to threatening situations.

The 'messengers' that relay information to your brain are called 'sense organs.' Your eyes, nose, ears, and mouth are all sense organs. Their shape and location, in turn, affects the appearance of your skull(cranium), which acts as the protective frame of your sense organs.

Below is an illustration showing the front and side view of a human skull(cranium).

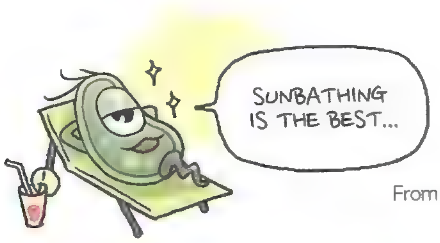
Illustration of the Skull / Painter 10/2011

You may be more familiar with your skull than the other bones in your body. Even so, the skull is a complicated structure to draw. Instead of trying to memorize every single detail of what the skull looks like, it would be more effective to learn the shape and role of sense organs within the skull first like the eyes, nose, ears and mouth. After all, the skull is simply a packaging for your brain and facial features.

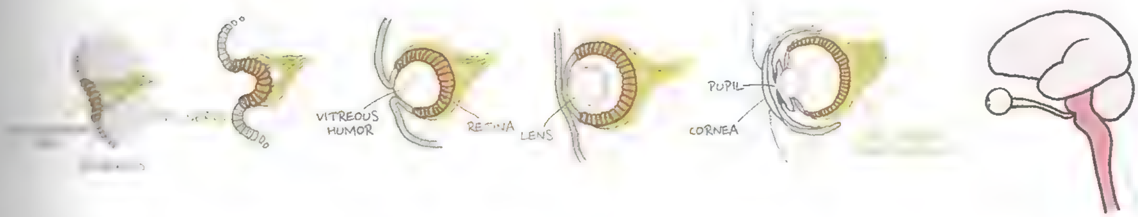
Your Sparkling Eyes

Protect Your Eyes!

Light is the most important external stimulus of all. Likewise, I'd have to say that the most important sense organ is the eye as it can detect visual information (i.e. light). Hence the eye has the nickname 'the second brain.' This is proof that your brain relies heavily on visual information, just as primitive single-celled organisms used photosynthesis to sustain life through light.



From the beginning of time, light was an important source of energy for all living things.

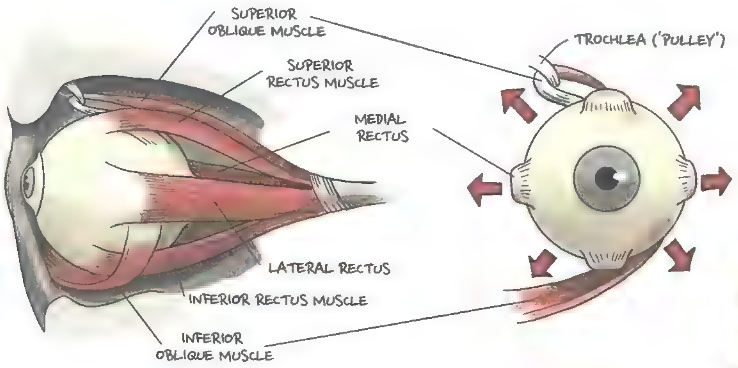


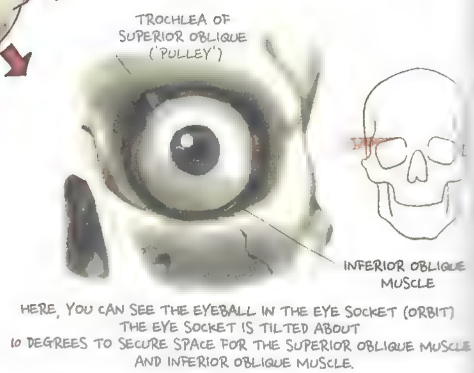
Photoreceptor cells are specialized cells in the retina that respond to light. The development process where photoreceptor cells in the retina develop to form the eyeball.
Today, many animals have eyes that have evolved in this way.

The ability to detect light is directly connected to survival. Therefore, the organs of the visual system must develop and function before all others. They are also the first organs to deteriorate.

There isn't a big difference in terms of size and function between the eye of an infant and an adult. It's just that an infant takes about 3 months to develop the ability to focus on objects.

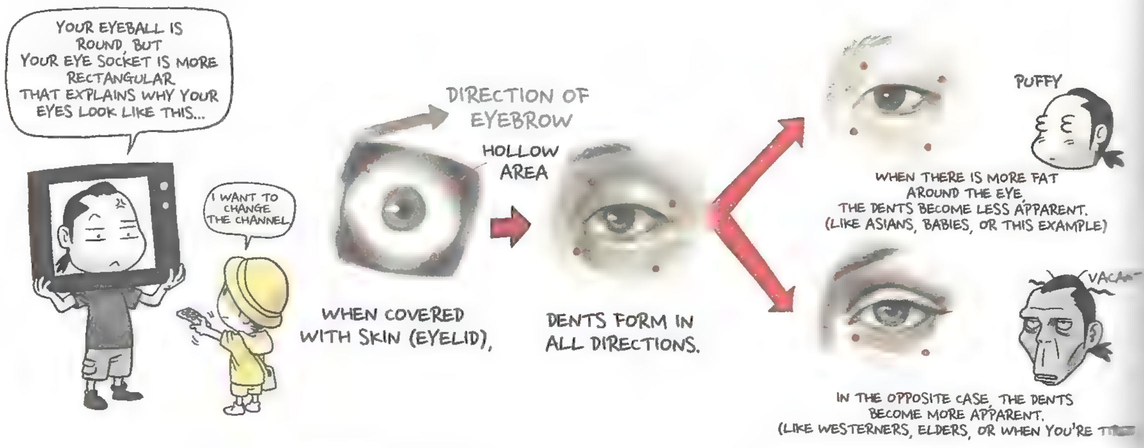
Your eye is an important and sensitive organ. The eye socket, also known as the orbit, is a bony socket that protects the eye. Six muscles work to move the eye in multiple directions.





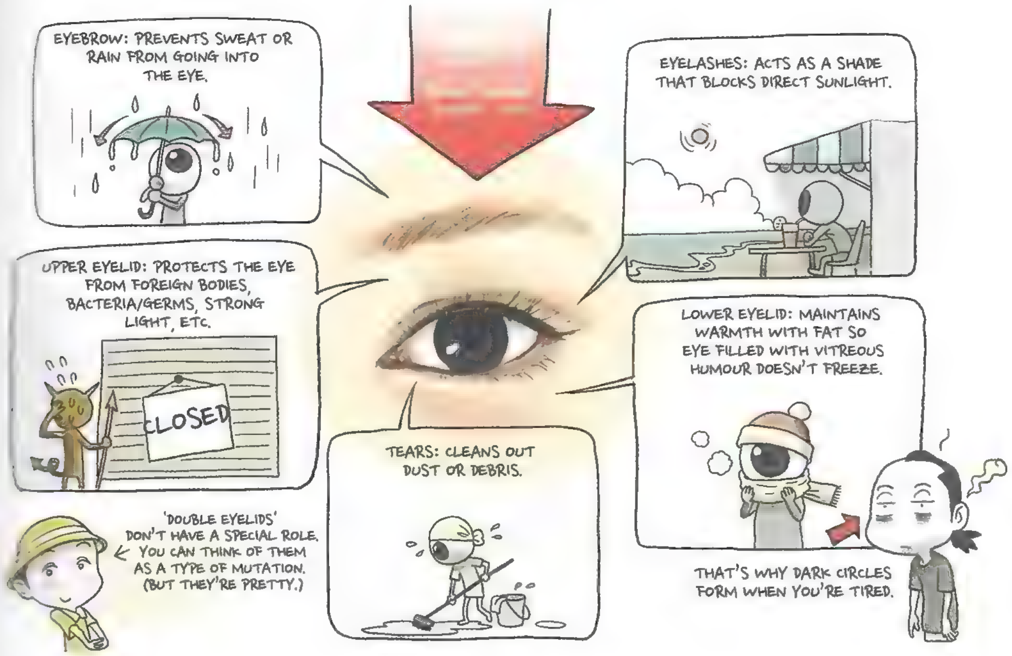
When you look closely at the shape of the eye socket in the skull illustration, you'll notice that it's not circular but more rectangular, like an old TV screen. So why is your eye socket rectangular when the eyeball inside it is round? It's to secure space for the six muscles that move the eye and to allow the eyeball to move better. Think about it this way; A ping-pong ball roll better on a rectangular plate tha a circular cup, right? It's the same idea.

Even when covered with skin, the shape of your eye socket looks the same. Most of the curves arou your eye is formed because of your eye socket.

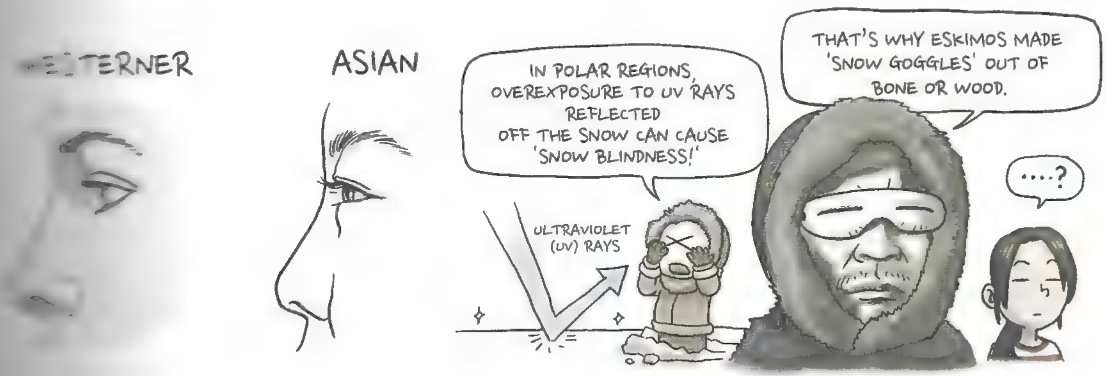


Keep in mind that the extent of indentation also depends on the protrusion of the forehead, nose, and cheekbone.

Even though your eyes are in the eye socket, it needs to be protected from direct sunlight, rain, snow, sweat, and other foreign bodies. Your eyelids and eyelashes provide an extra layer of protection.



Everyone is equipped with features to protect their eyes, but they differ slightly based on certain factors, such as living condition and climate. For example, those who live in areas with intense sunshine have dents to protect their eyes from direct sunlight. Those who live in areas with lots of snow have thick eyelids to protect their eyes from the cold.



The eyes of Eskimos living in polar regions are small to protect their eyeballs from freezing and to block as much of the UV rays that reflect off the snow. Still, snow goggles are a necessity for activities that require long-term exposure to UV rays, such as hunting or traveling.

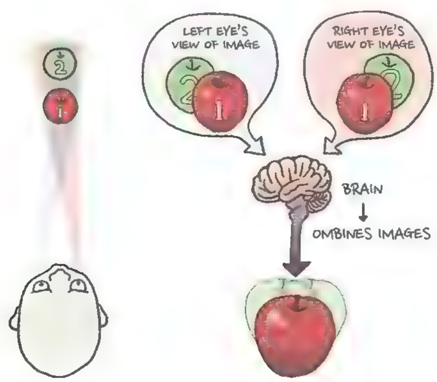
■Eyes, Why Are You This Way?

I've already mentioned this several times, but the appearance of a living organism is heavily influenced by its environment. Keep in mind that an organism's appearance is never determined randomly or by coincidence.

The same goes for why we have two eyes. The reason we have two eyes is because we live in a three-dimensional world. Being able to recognize three-dimensional objects is crucial for survival! Here's an interesting example.

(Kaede Rukawa) characters design
© 集英社. <SLAM DUNK>)

If you've read the Japanese manga series Slam Dunk by Takehiko Inoue, you probably remember this memorable scene. Kaede Rukawa injures one eye during a game and has trouble estimating his distance from the hoop. So, he closes both eyes, trusts what his body remembers, and shoots a free throw successfully. (Such a thrilling scene!)



The reason we can't see three-dimensional objects with one eye is because each eye sees a different image from a different viewpoint. The brain Then combines the two different images to give the perception of depth.

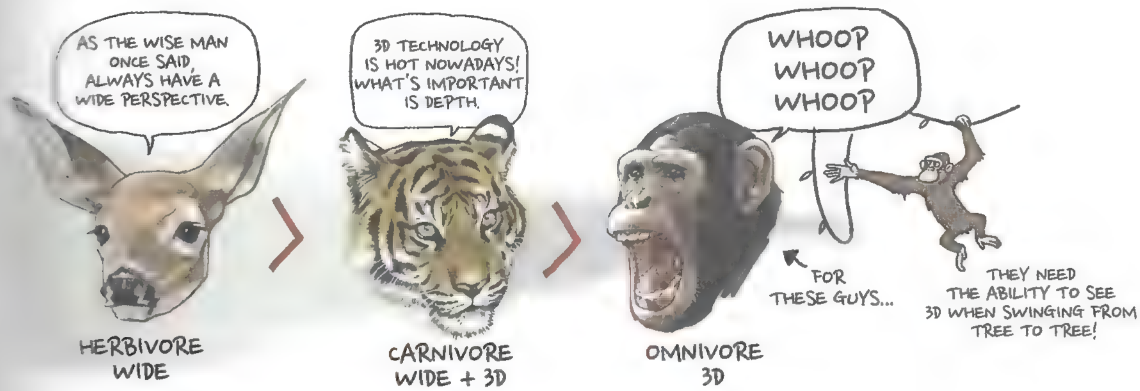
The once popular Magic Eye illusions and the movie Avatar, are known for its 3D images. They were created based on the same mechanics of the eye. Simply put, stereoscopy is a technique that creates a three-dimensional effect by presenting two separate images, one for the left eye and one for the right eye.

Of course, some people may question whether playing basketball or watching 3D movies has anything to do with 'survival.' But one thing is for sure: species with eyes that can detect 3D objects are more likely to survive than species with eyes that can't.

However, there are times when the ability to see a wider range is more important than seeing three-dimensional objects.

ision of herbivores, carnivores, and omnivores - sky blue area represents 'field of view,' gray area represents the 'blind spot.'

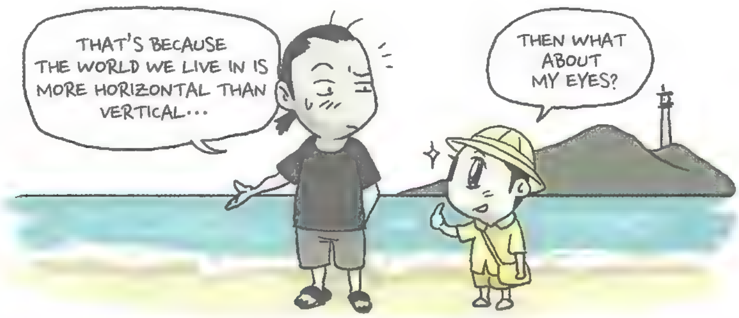
While most carnivores have forward facing eyes to track and pursue prey, most herbivores have eyes on the side of its head. Side eye placement enables greater peripheral vision, and allows the animal to see approaching predators.



Once again, carnivores (predators) have forward facing eyes and herbivores (prey) have eyes on the side of their head. Interestingly, the same idea can be applied to human facial features. Let's take a look at the images below.

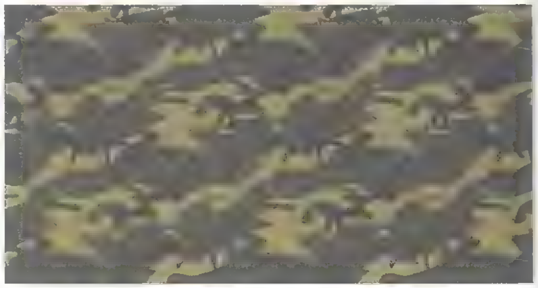
You may have already noticed, but the only difference between the two images is the spacing of the eyes. Eyes that resemble a herbivore makes women look passive and gentle, while the eyes that resemble a carnivore makes women look active and smart. Some people even get plastic surgery because the competitive nature of modern society tends to prefer the look of a carnivore more than a herbivore.

While we're on the topic, I have another question. Why are our eyes positioned horizontally and not vertically?



I'll talk about pupil size in more detail later, but a big eye makes the pupil look bigger. Enlarged pupils make you look youthful and tend to make a good impression.

This also goes along with the idea that the ability to perceive width is a greater advantage for survival than the ability to perceive height. But in the modern world where tall buildings are prevalent, perhaps it's natural for your eyes to pop wide open.

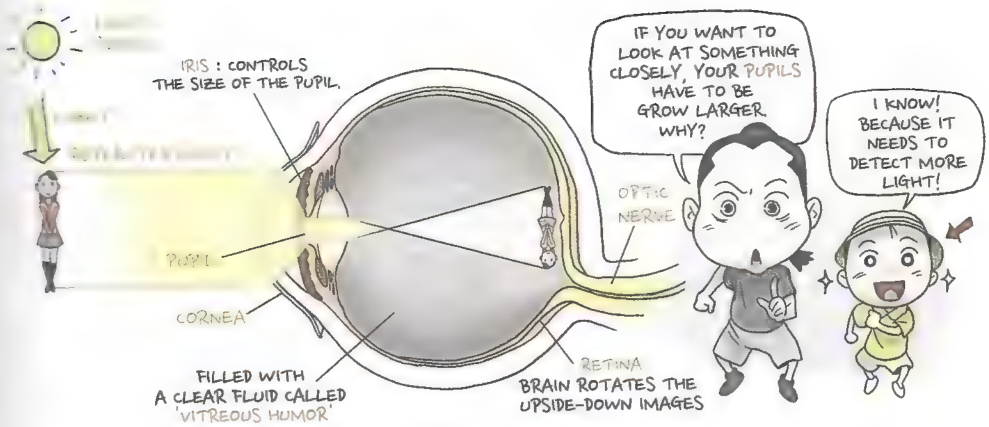


Camouflage patterns on military uniforms are usually horizontal because they take advantage of the fact that human eyes are used to horizontal scenery.

■Pupil, a Communication Tunnel

As mentioned earlier, the eye is an organ that detects light. But besides the anatomical role as a sensory organ, the eye also plays an important role in terms of communication. While our eyes allow us to see and act as a survival tool, our eyes are also seen by others and act as a cultural tool.

In order to know what role your eyes have in terms of communication, we need to understand its structure. When drawing a portrait, the pupil, which is in the center of the iris, heavily influences the person's appearance. Your eye has one mission, to pick up light. The light from something you are looking at passes through and is picked up by retina. Then, the image is sent to the brain. To clarify, let's take a look at the next image.



The structure of your eyeball. If the shape of your eyeball changes due to pressure (intraocular), it can lead to nearsightedness or astigmatism.

... your eyes which detect light, should be as close as possible to your brain. This reflects the ... connection of the eyes to the brain. Hence the saying, "the eyes are the window to the soul." ... Let's try to spot the difference in the two images below. Can you find it?

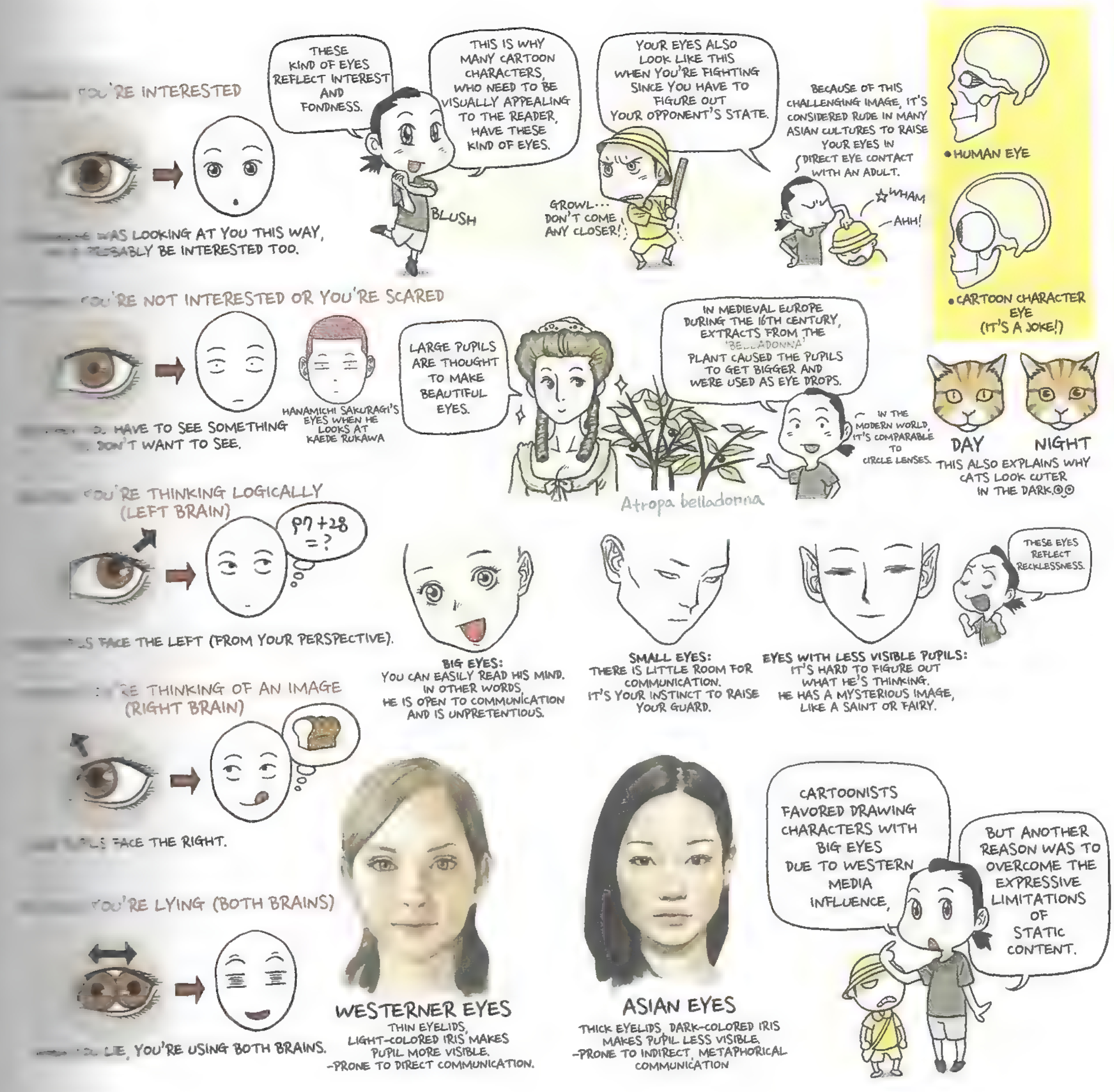
The two images may look the same at first, until you notice something's off. That's right. The pupil size is different. When it's dark, your pupils get larger to let more light in. But, the same thing happens when you stare at an object of interest. These biological changes also play a big role in human relationships. It wouldn't be an exaggeration to say that your eyes are a clear indicator of your brain's activity. Therefore, this phenomenon has remained a hot topic among artists who strive to express visually and for cartoonists who have actively applied this concept to their work.

The red-eye effect often occurs when a photographic flash is used in a dark environment. The bright light that enters through the pupil reaches the retina and reflects back, and that red light is captured by the camera. But the image on the right isn't a representation of the red-eye effect. It appears to be the cartoonist's attempt to express the character's hatred toward his opponent.

An example of how the pupil affects appearance - 'SAKUN girls' / 2013

They may look like two different people, but both images were drawn in reference to the same person. Let's focus on the different 'eyes' as well as the changes in accessories and facial expressions. The overall appearance of a person may drastically change depending on the color of the iris, the brightness of the eye, the extent to which the eyes are open, and most of all, the emotional state of the person.

Your eyes may be a small sensory organ that makes up barely 1% of the human body, but their role and existence is essential. This explains why cartoonists place a huge emphasis on the eyes to display the character's emotions through a still image. Let's look at some more examples.



While Westerners enjoy making eye contact with another person during conversation, Asians tend to feel uncomfortable. The different communication style can be traced back to the anatomical differences of whether the pupil is visible or not. This also has a profound effect on both cultures. So it's not surprising that the smaller eyes of Asians were considered exotic to Westerners.

Wait! Eyes in Animation and Artwork.

While Westerners thought the small eyes of Asians were exotic, Asians thought the big eyes of Westerners were beautiful. This idea of Western beauty flourished after the Industrial Revolution in Europe when visual media such as posters and films were actively brought into Asia. People tend to feel comfortable with what they are used to so the idea of beauty is closely related to the effect of simple contrast.


Now, it's commonly thought Japanese anime characters (refer to the image above) were drawn with big eyes due to Western media influence and idolization of Westernized beauty. But in addition to that, it may have been a solution for artists and cartoonists who struggled with expressive limitations compared to live-action film makers who worked with real actors that can freely move and express their emotions. The most effective way to overcome such limitations is to maximize or minimize the character's features to convey his emotions. Ironically, such methods have made it possible to convey a larger variety of emotions.


It's obvious that a person's overall image will change depending on his or her eyes. Take a look at the image on the right. Her eyes are not small, but her pupils are not clearly visible because she is looking down. This makes it difficult to figure out her emotions. For the same reason, this technique was commonly used in religious artwork that emphasizes the sacred leader.

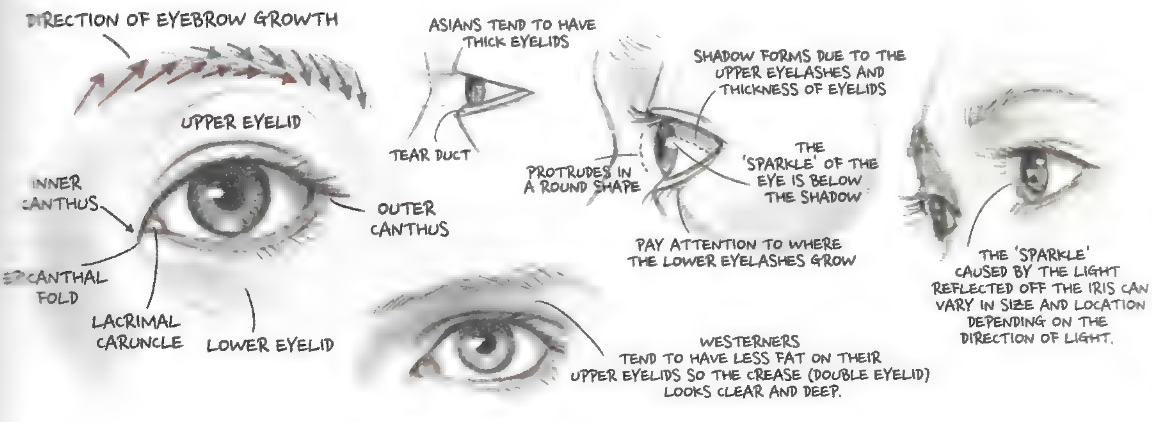
(left : Julian Opie - "Blur", 2000, National Portrait Gallery, London.)

Let's look at one more example. On the left is the work of Julian Opie, a famous British artist. On the right is my self-portrait, influenced by his work. All of Opie's portraits have a distinctive feature in which the person's eyes are drawn as simple dots. It symbolizes the conformity and anonymity of modern people.

The eyes have a significant role both biologically and socially. So, it makes sense to spend the most time on the eyes when drawing a person. Just by changing the size of the pupil, different emotions can be expressed. You can see how much power the eyes have from these examples.

When Drawing the Eyes

The illustration below isn't really a how-to for drawing eyes. Rather, it tells you what to watch for when drawing eyes. It seems meaningless to go over the steps of drawing eyes, since we are so familiar with it. Additionally, there are multiple eye variations and providing one way would be obsolete. Thus, it is more than enough to review the relevant terminology and become familiar with common parts. You can draw eyes in your own style, but make sure to keep the basic structure in mind.

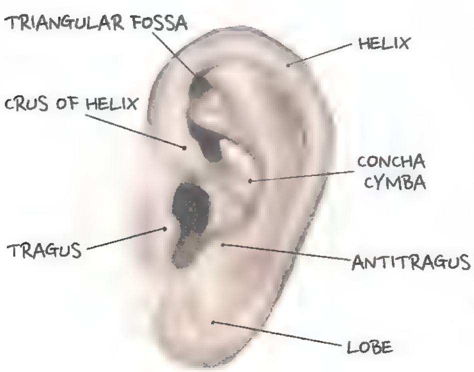


Your Soft and Tender Ear

■Enhanced Hearing

Remember a time when you were lying in the dark at night and all the surrounding noise seemed louder than usual? Perhaps it felt that way since everything is relatively quieter at night. But there's a more significant reason. When your eyes can't function to their optimal level, your ears step in and take over.

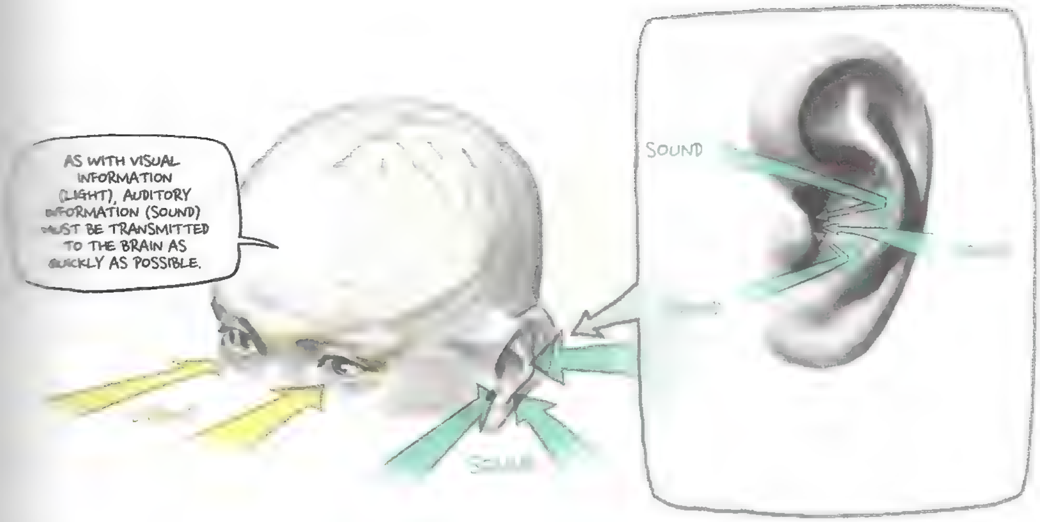
Your eyes and ears have a complementary relationship. In other words, when one can't do its job, the other quickly develops its senses.



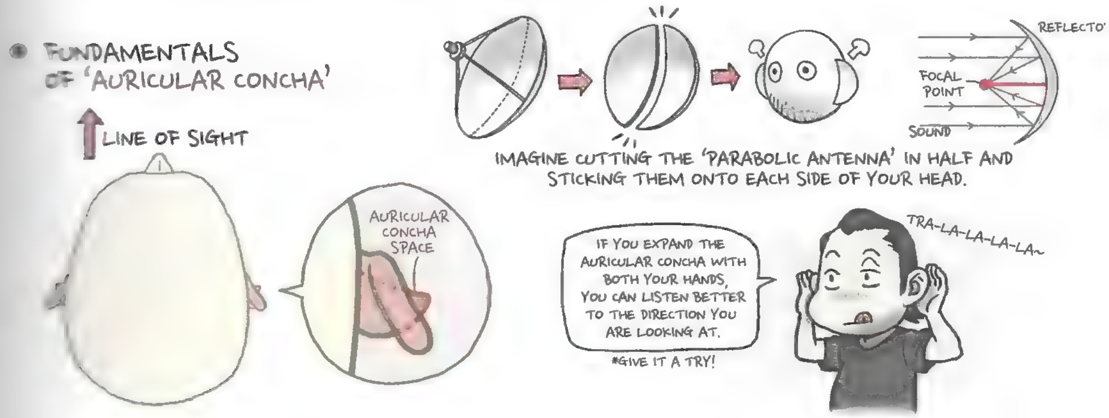
Parts of the Ear

In some ways, the ability to detect sound may be much more important to survival than the ability to detect light. Your eye is an extremely complex and delicate organ that tires easily and deteriorates quickly. Therefore, there is always a possibility that the object in sight may be distorted.

For this reason, the ear is located at as close to the brain as the eye so that it can take over the eye's role. Also, its complex structure enables the ear to collect a wider range of information than what the eye can see.



the image above, the ear is structured so that the central area of the auricular concha is caved, to effectively gather sounds from all around into one place. While we're on the subject, let's a closer look at the auricular concha.

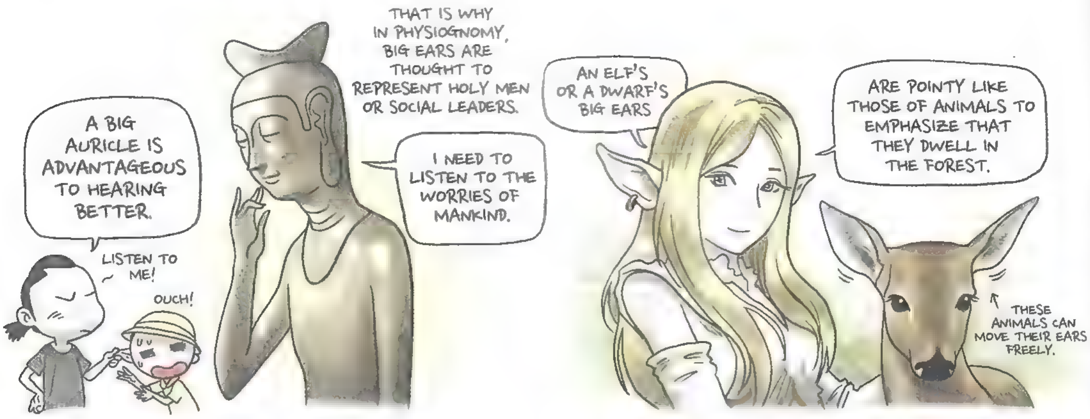


Please note that the image of the auricular concha above is exaggerated to help you understand, although there are some cases where the auricular concha sticks out beyond the helix

Part of the cartilage that surrounds the various area of the ear, including the auricular concha, is called the earflap (auricle).
Despite their important function, the ears don't get much attention when drawing the face.
That's because they are often covered by the hair or hats and such, and most of all, because their shape is quite difficult and complicated. But it will be easier to understand if you think of the 'earflap' that surrounds the 'auricular concha' as we have covered earlier. Please refer to next page on how to draw the ears.

■Perk Up Your Ears

A large auricle indicates that the concha is large too. If the concha is large, naturally hearing is enhanced. In the world of animals, herbivores usually have larger ears than carnivores. This is because they need to hear any predators approaching from behind. For these reasons, big ears are symbolic of being 'gentle' or 'wise.'



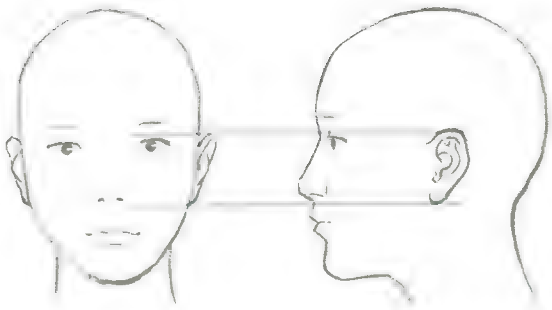
The ear is said to grow throughout life. Therefore, an elongated lobe indicates that the person has more experience in life. However, if it is the top of the ear that is longer, like in the case of elves in North European mythology, it symbolizes something else. The elves' ears were originally only slightly pointy, but this feature was exaggerated in Japanese fantasy mangas.

Another interesting point about the ear is that other than having to capture sound efficiently, it is an external organ like the nose, therefore most of its structure is made up of cartilage and is flexible. If the ear was made up of fibrous tissue or fat, it would be difficult to maintain its shape, and if it was made up of bones, it would not be flexible against outside impact. The cartilage is what allows different kinds of piercings and earrings.

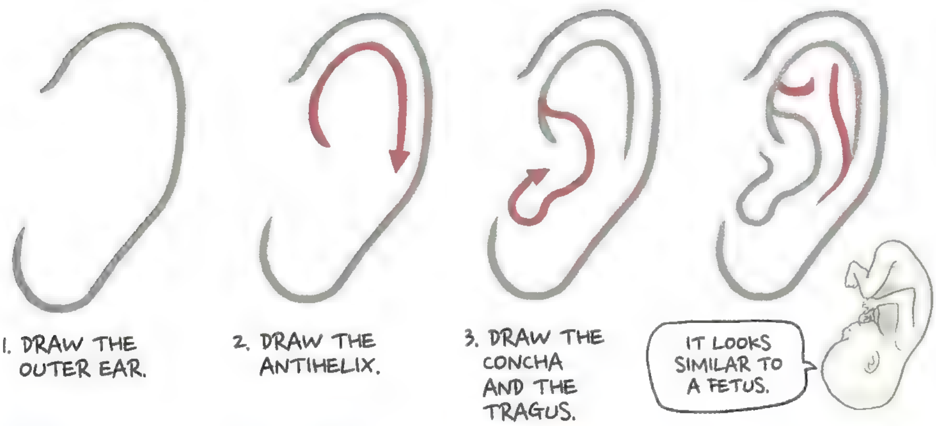
Let's Draw the Ear

...mentioned before, the ear is the least ...ved organ on the head when drawing. ...is because although it is a cartilage, it is ...rectly linked to the cranium, and therefore ...not affect the cranium.

...te not getting much interest, the ear ... up a big part of character drawings. The ... drawn in details, helps to complete the ...racter. Once you become familiar with the ... drawing formula, you can apply it to other ...gs. So, take a look at the below formula ...fully.



The location of the ears on the face is different for every person, but it usually they are located between the eyelids and the nose. In physiognomy, a person's character is determined based on the location of the ear.

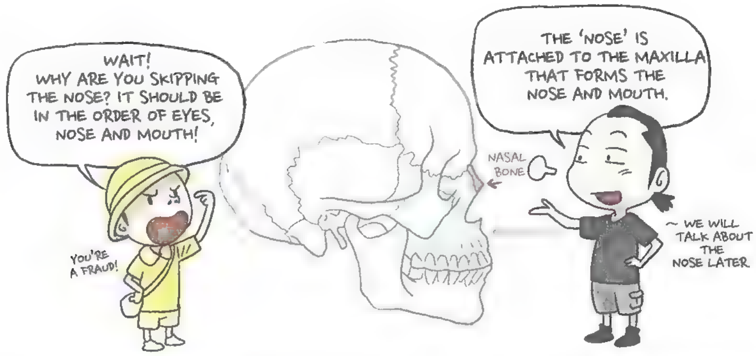


The ear seen from various angles.

The Masticating Mouth

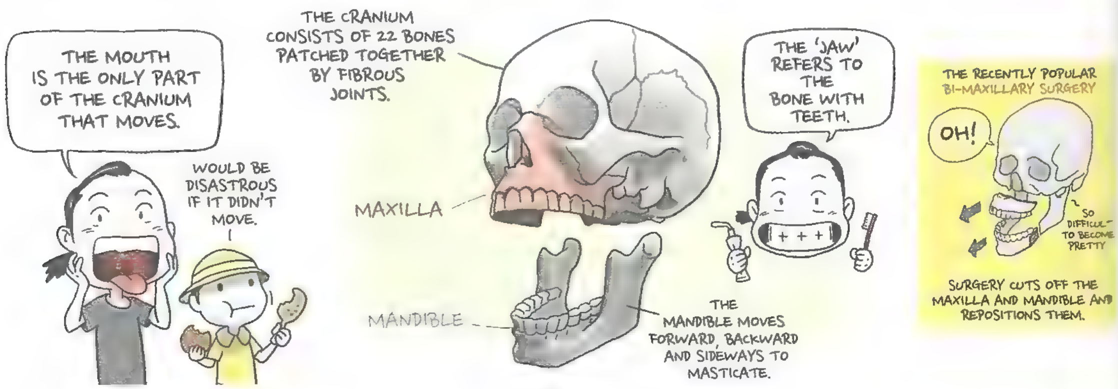
■The Structure of the Jaw

For the brain to work, it needs to not only 'collect data' but also to collect 'energy sources.' This means that it needs to eat something. Other than the oxygen we consume with our lungs multicellular organisms like humans need to consume other things, so we need an organ we can use to attack and eat. The mouth is used for consuming food, sensing taste and language communication as well. In other words, the mouth is a sensory organ and at the same time a grinding factory.



The eyes, nose and mouth are in that order on the face, but this distinction is not that important from an anatomical perspective.

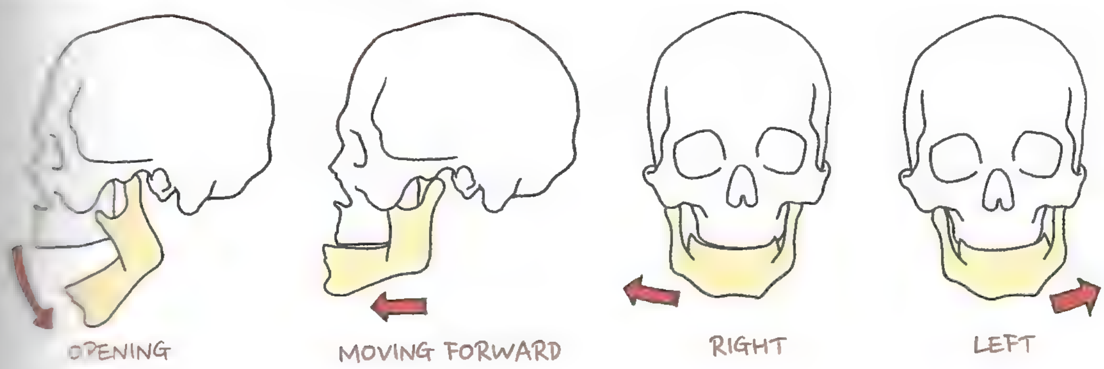
The mouth needs to move, whether it is to chew, taste or speak. That is why the head consists of a big fixed bone (head, cranium) and a moving bone (mandible). The mouth is located at the lowermost part of the face so that its movement, vibration and any harmful matter that enters it will not directly impact the brain.



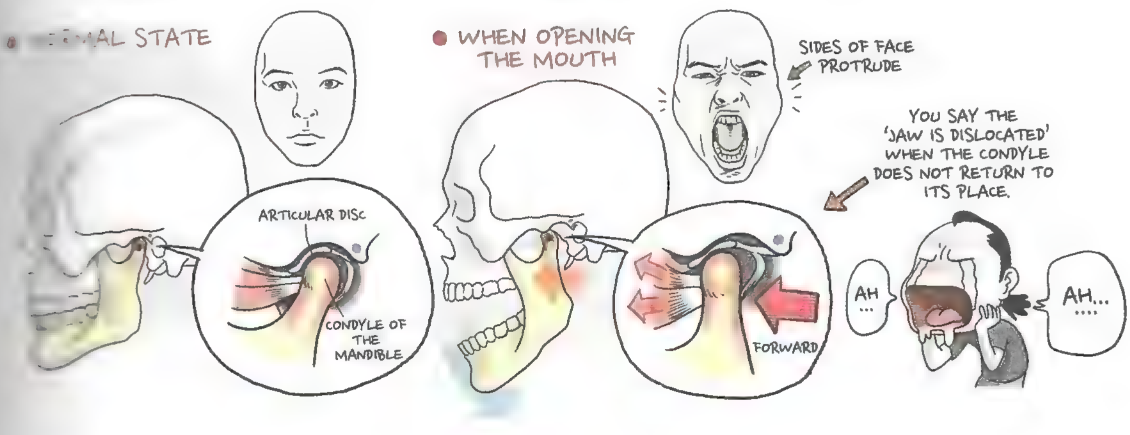
The lower jaw is capable of many movements

One thing you should not get confused about is that the maxilla is 'sutured' to the cranium and therefore, they cannot move. Opening the mouth and biting actions are movements made by the Mandible. Mastication is the continuation of these two movements,

THE MOVEMENT OF THE MANDIBLE

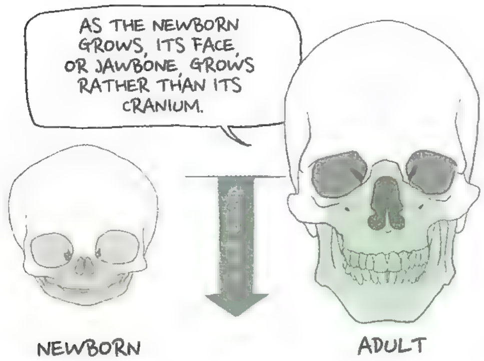


As shown in the above diagram, the mandible moves by using the 'articular disc' found between the condyle of the mandible and the mandibular fossa. See the picture below.



When you open your mouth, the condyle of the mandible is moved forward by the 'lateral pterygoid muscle', and the muscle is contracted causing the sides of the face to protrude. That is why when you open your mouth wide, it is noticeable from behind.

■The Secret to Looking Young



During the time the newborn grows into an adult, the cranium grows about 20% while the jaw grows 70%.

The jawbone greatly affects the appearance an overall impression of the face.

At the time of birth, the cranium is already almos completely developed to protect the brain and eyes. Unlike the cranium, the jawbone only takes up a third of the face at birth, and grows to take up half of the face in adulthood. A well-developed jawbone symbolizes 'independence as the person is able to grind and digest instea of having to consume liquid food. That is why if one has a small jawbone, people get the impression that the person looks young.

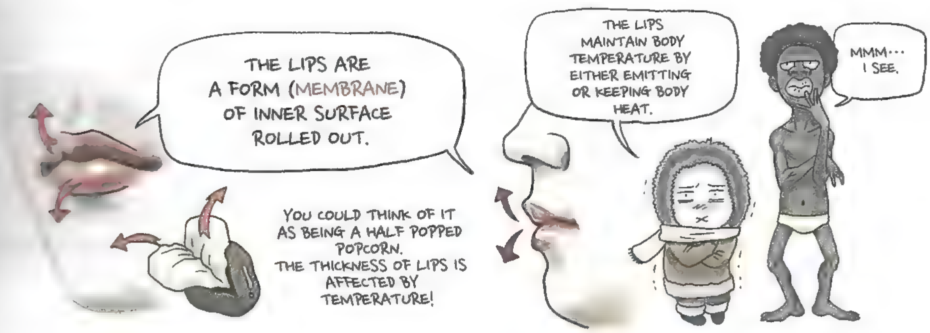
In case of confrontation, it is advantageous for one to be on higher ground because one can see the surroundings better. On the other hand, the person in the lower ground will be looking up at the person's chin. In behavioral psychology, people raise their chin at others when trying to establish superiority.

Looking up gives the impression of being cute, passive, innocent, and vulnerable.

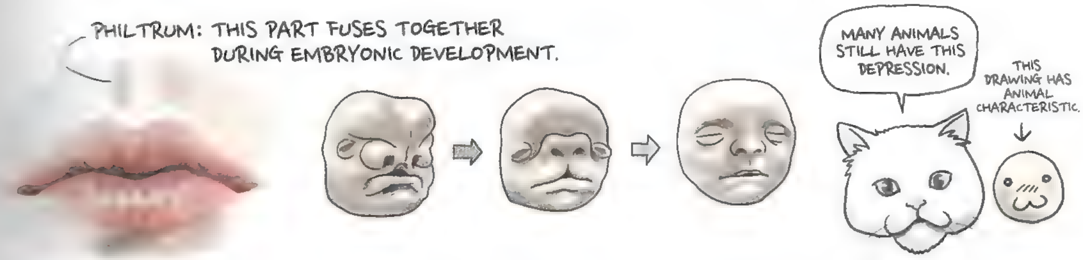
Raising the chin and looking down gives the impression of being authoritative, having confidence and superiority.

Lips

...s briefly take a look at the 'lips' that are the symbol of the mouth and 'philtrum.' The lips are a ...ous membrane. Simply put, it is an inner skin exposed in order to release body heat (the anus ...ais also). That is why the mucous membranes are darker than the skin color. Lips are ... sensual because of its appearance and because it shows the inner state of the body. For ... when a person is sexually aroused, the lips become fuller and redder because of increased ...

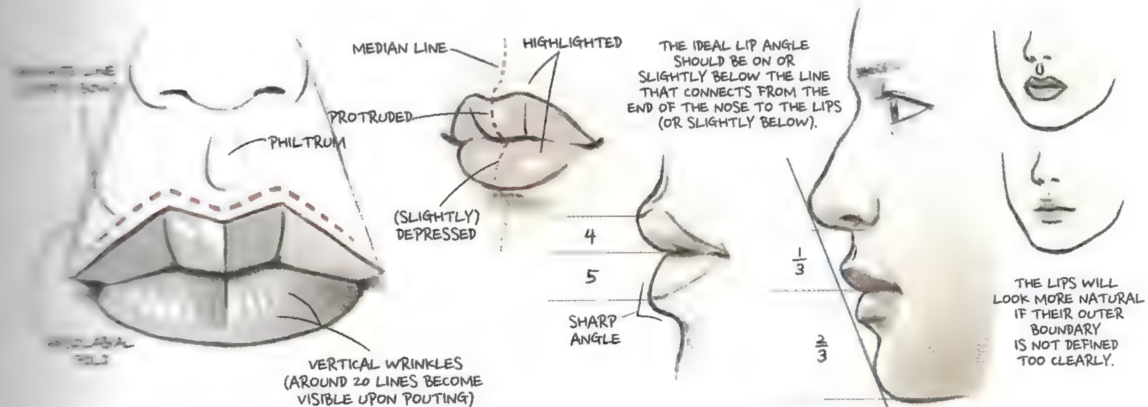


'Mucous membrane' refers to the epithelium covered with mucous glands. Unlike the rest of the skin, these areas are soft and red because of the capillary vessels showing inside.



If the palate and lips are not fully formed during the fourth to seventh weeks of fetal development, it results in a cleft lip.

...here is how the lips are drawn. Like other parts, it is important to first know the structure.



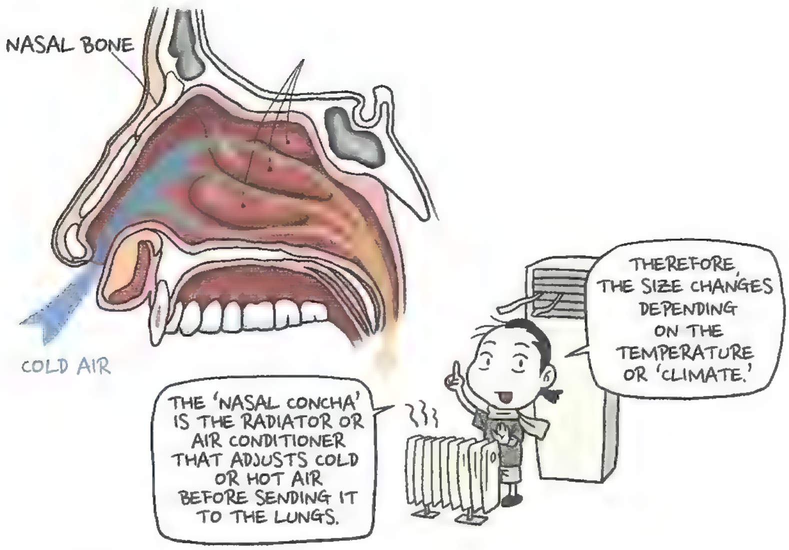
Flaring Nose

■The Secret Behind the Nasal Ridge

The nose is located between the eyes and m to detect 'smell,' or particles in the air. Other th smelling, the nose is in charge of 'respiration, inhaling oxygen and exhaling carbon dioxide. Breathing is an exercise that we need to do throughout our whole life during our waking and sleeping hours, so the nose becomes easily exhausted compared to other organs. The two nostrils take turns breathing every two to five minutes. You might have experienced when you had nasal congestion that you could suddenly breathe easily. This is because the other nostr has started breathing.

The names of each part of the nose. The hook nose shape can also be congenital.

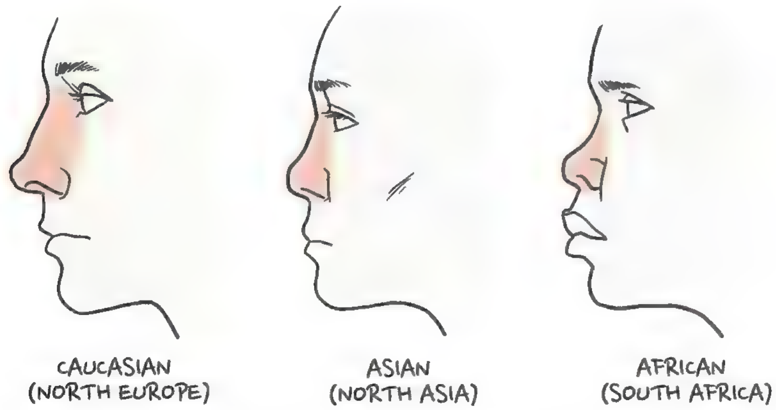
Although air is essential to life, it also contains dust or fine particles that are harmful to the body. Also, the air can be dry or cold, which is not good for the respiratory organ. The 'nasal cavity' is an area inside the nose that heats up or cools down the external air quickly before sending it to the respiratory organ, sort of like a radiator and filter. This is called the 'nasal concha.'



The 'nasal concha' structure consists of top, middle and bottom and in between are the superior nasal meatus, middle nasal meatus and inferior nasal meatus, where the outer air pass through the respiratory tract and into the lungs. It takes only 0.2 seconds for the outer air to be adjusted to the body temperature.

The nasal concha, as mentioned before, is sensitive to temperature, or 'climate,' so it is a major factor that determines the length of the nose of different races.

• NOSE LENGTH OF EACH CONTINENT

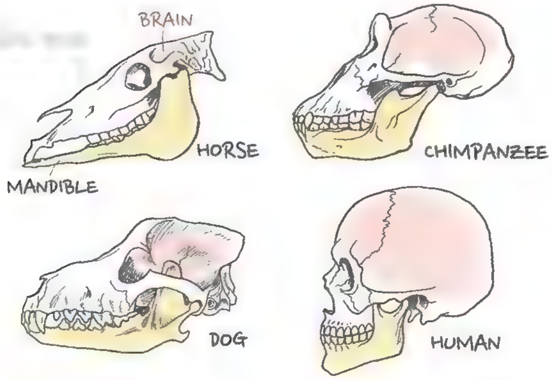


It is not just the nose that is influenced by the climate or environment. Other body parts are influenced as well. These characteristics are becoming less clear as people become more global and there is more exchange among people.

■The High Nose Line

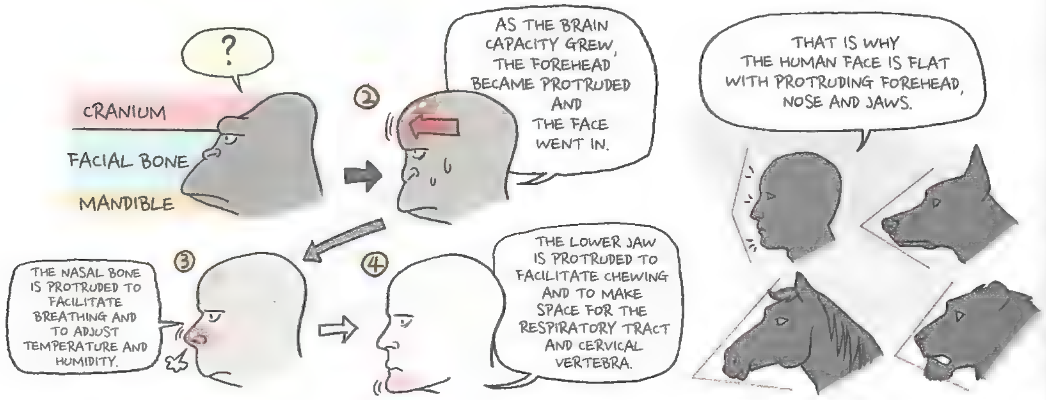
An interesting fact is that only the human species has a nose that juts out.

For your reference, the elephant's long trunk is not made of bone, but muscle like that of the human tongue.



This has to do with the human's large brain capacity. Unlike other animals, humans did not have any special strength or weapons. Therefore, its brain had to evolve for survival, and along with this development the brain grew bigger and formed the broad human face.

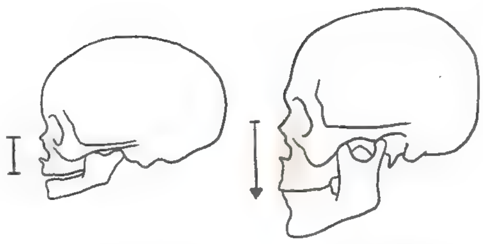
Drawing: brain capacity of different animals.

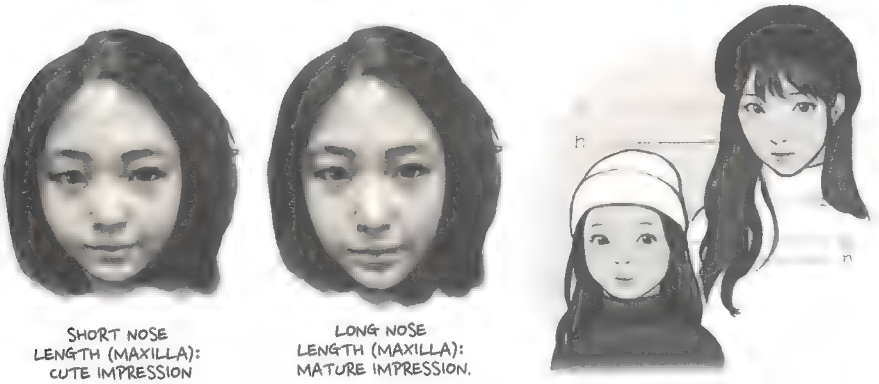


The nose is at the forefront of the body and juts out, making it vulnerable. The 'Iron Man' suit was made for the purpose of battle, so it would be disadvantageous to have something sticking out at the front of the face.

While the nose 'height' is influenced by the external environment, the 'length' is closely related to the growth of maxilla that was explained before. In other words, the nose length determines whether a person looks young.

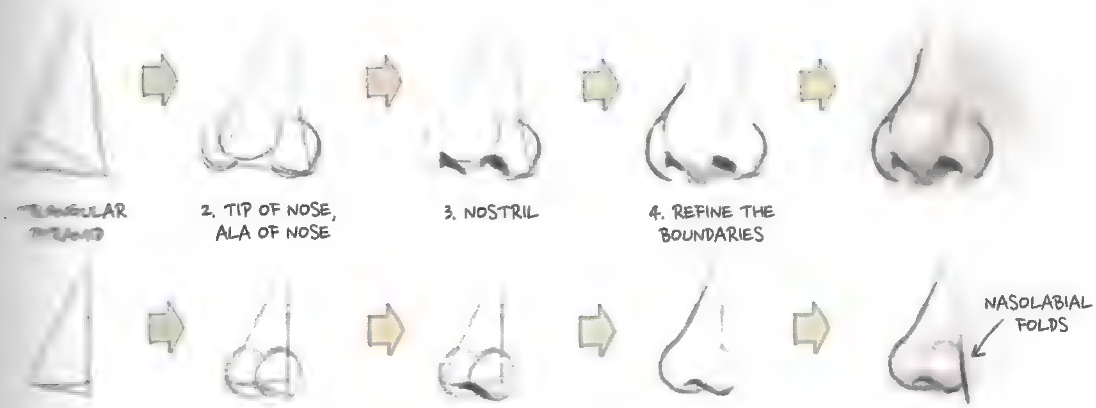
An interesting fact is that in physiognomy the 'nose' symbolizes the phallus. However, reproductive capacity and nose size are actually irrelevant. That is why in cartoons, beautiful female characters are often given a small nose, or in many cases no nose at all. This is common, so see if you can spot such an example.





The length of nose and jaw, along with the size of eyes, determine the impression a character makes.

To wrap-up, I will briefly explain how to draw the nose. As with drawing any part of the face, there are many different ways to draw the nose. The nose can take on many different looks depending on how one draws it. It is actually quite difficult to draw a natural-looking nose. Based on the below steps, try drawing the nose from many different angles.



Skull: Detailed Shape and Names

So now, we should take a look at the actual shape of the skull.

First, let's look at the skull from the front and the names of each part. It is not easy to memorize all of the anatomical terms, but as I explained before, it will be much easier for you to understand and remember the names if you associate them with the shapes.

Front View of the Skull

❶ **Frontal bone:** Bone that forms the forehead.

❷ **Orbit:** Cavity or socket of the skull that houses the eyes. The cavity serves to protect the eyes.

❸ **Zygomatic arch:** The temporal muscle needs to pass from the temporal bone ⑪ to the mandible, so seen from the top, it has an open area like that of an arch. Refer to the next chapter on 'The Skull from Various Angles'

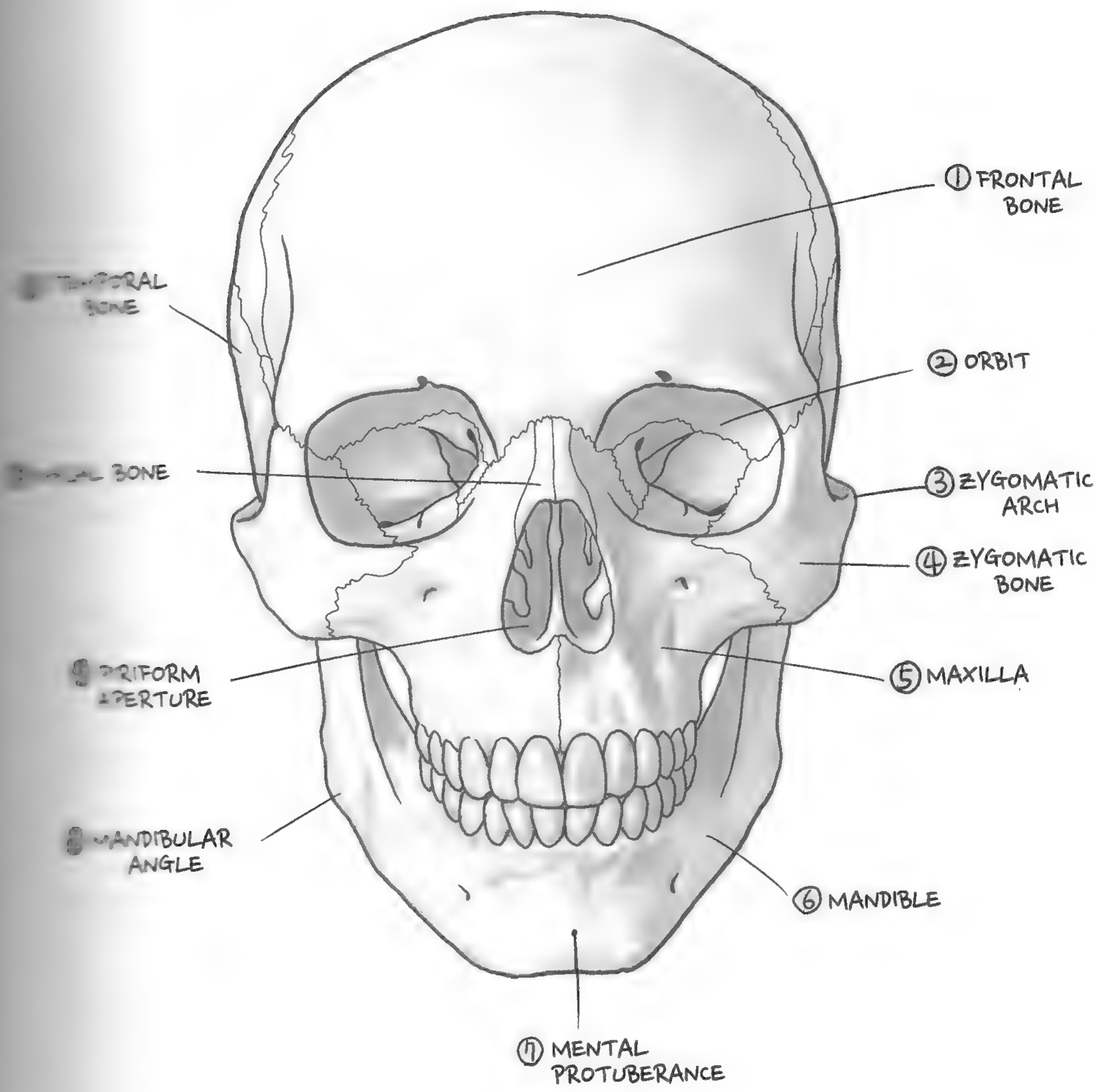
❹ **Zygomatic bone:** This bone is projected because it is attached to the muscles that are connected to the mandible

❺ **Maxilla:** The bone where the upper teeth are attached.

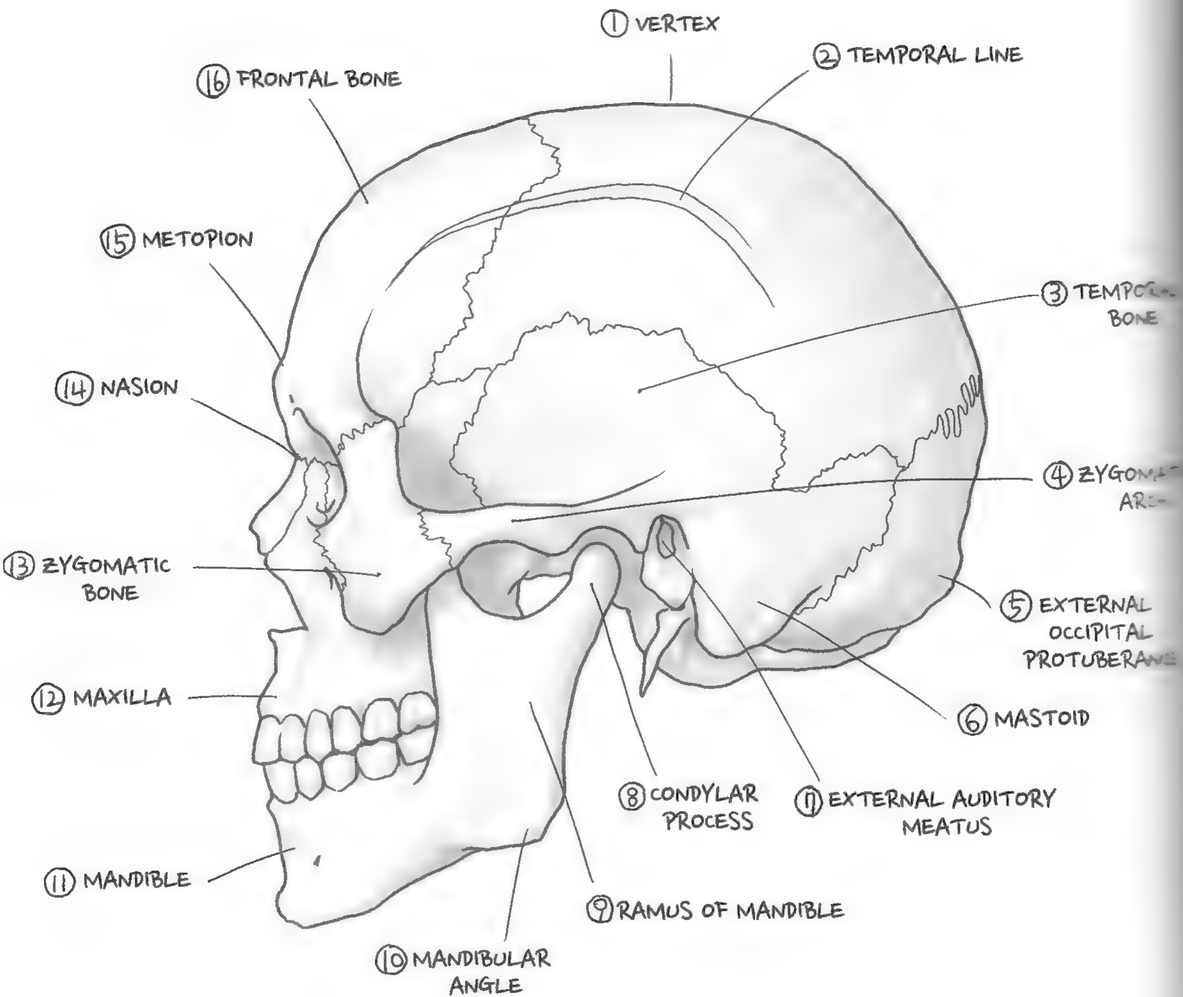
❻ **Mandible:** The bone where the lower teeth are attached (teeth are not 'bones.') For your reference, the average a has a total of 32 to 34 teeth.

❼ **Mental protuberance:** This is the part that juts out on the front of the mandible. A 'protuberance' is an area that sticks out compared to the surrounding area.

❽ **Mandibular angle:** The angles that form the sides of the mandible. The masseter muscle that firmly closes the jaw attached here. Men usually have a more developed angle.



① FRONTAL BONE
② ORBIT
③ ZYGOMATIC ARCH
④ ZYGOMATIC BONE
⑤ MAXILLA
⑥ MANDIBLE
⑦ MENTAL PROTUBERANCE



1 VERTEX
2 TEMPORAL LINE
16 FRONTAL BONE
15 METOPION
3 BONE
14 NASION
4
13 ZYGOMATIC BONE
5 EXTERNAL OCCIPITAL
12 MAXILLA
6 MASTOID
8 CONDYLAR PROCESS
17 EXTERNAL AUDITORY MEATUS
11 MANDIBLE
9 RAMUS OF MANDIBLE
10 MANDIBULAR ANGLE

- **Apertura piriformis:** The name refers to its pear-shaped opening. The sharp pieces that stick out inside on both sides are the nasal concha we saw when learning about the nose. The front of the nasal cavity is filled with cartilage.

- **Nasal bone:** When we say that a nose is broken we are usually referring to this part. It means the joint between nasal bone and cartilage has been damaged.

- **Temporal bone:** The temples move when the veins pulse.

Side View of the Skull

from the vertex, clockwise. Terms that were previously explained are omitted here.

- **Vertex:** This is the topmost part of the human body, it is also called the 'crown.' To be exact, 'crown' refers to the hair whorl but 'vertex' is the highest point of the skull. This is the part we measure when taking height measurements.

- **Temporal line:** The temporal muscle that is used for mastication is a broad, fan-shaped muscle that starts from below this line, and goes past the zygomatic arch. It then inserts into the coronoid process of the mandible. Refer to the muscle part for further details.

- **External occipital protuberance:** This part juts out at the back of the head, towards the bottom, and can be felt with your hands. The trapezius starts from here. I explained before that protruding bones mostly have muscles attached to them.

- **Mastoid:** This part protrudes behind the ear and can be felt with your hands. It is about the size of the top of your thumb joint. It attaches to the sternocleidomastoid muscle that starts from the sternum and clavicle. For your reference, the term 'protsuberance' is often used in anatomy. It refers to an anatomical landmark that appears sharp or prominent.

- **External auditory meatus:** The ear canal that spans from the outer ear to the eardrum. The ears are not visible on the skull bones.

- **Condylar process:** The joint where the cranium and mandible are connected by the articular disc. There is another process in front of the condylar process called 'coronoid process.' It is connected to the bottom part of the temporalis.

- **Ramus:** The part on each side of the mandible looks like branches. For your reference, the front side of the mandible is called the 'body of mandible.'

⓮ **Nasion:** It means the 'root of nose.' This is the part that separates the frontal bone and nasal bone. In other words, this is where the nose starts. In physiognomy, it is considered to be the 'birthplace of wisdom.'

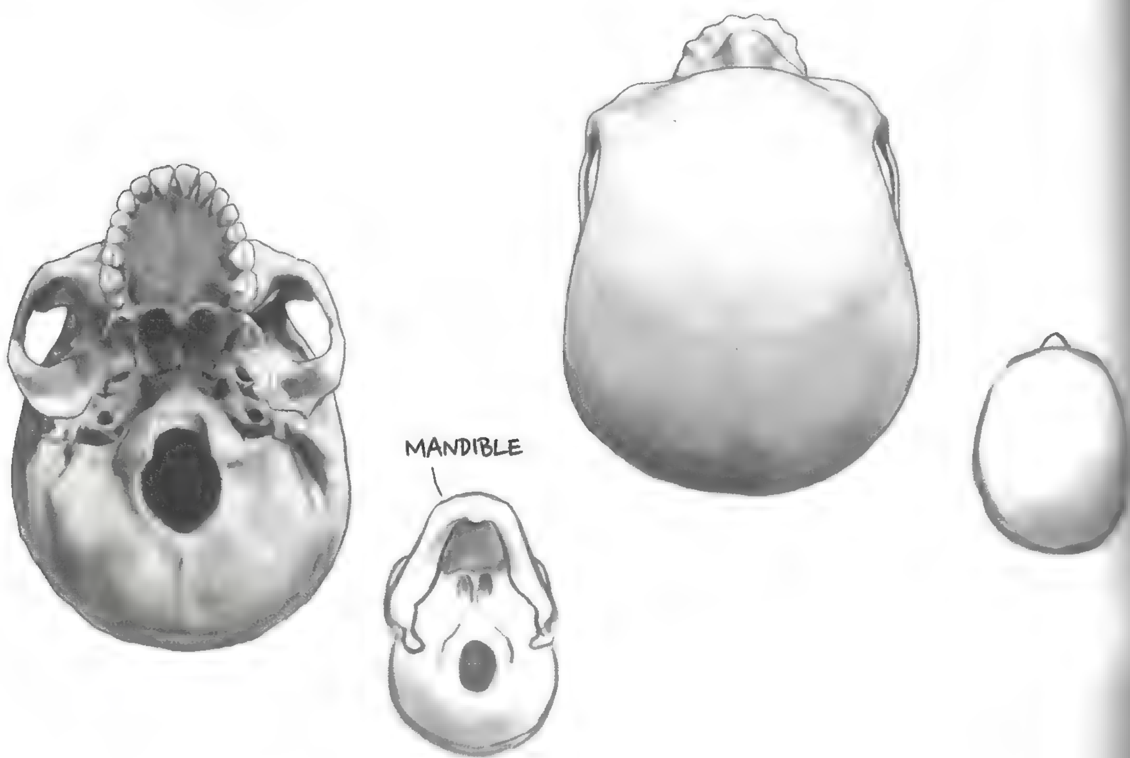
⓯ **Metopion:** This is the part that protrudes above the nasion. The metopion can be seen from the side view of the skull. Along with the previously mentioned mandibular angle and external occipital protuberance, this part is more developed in men than women.

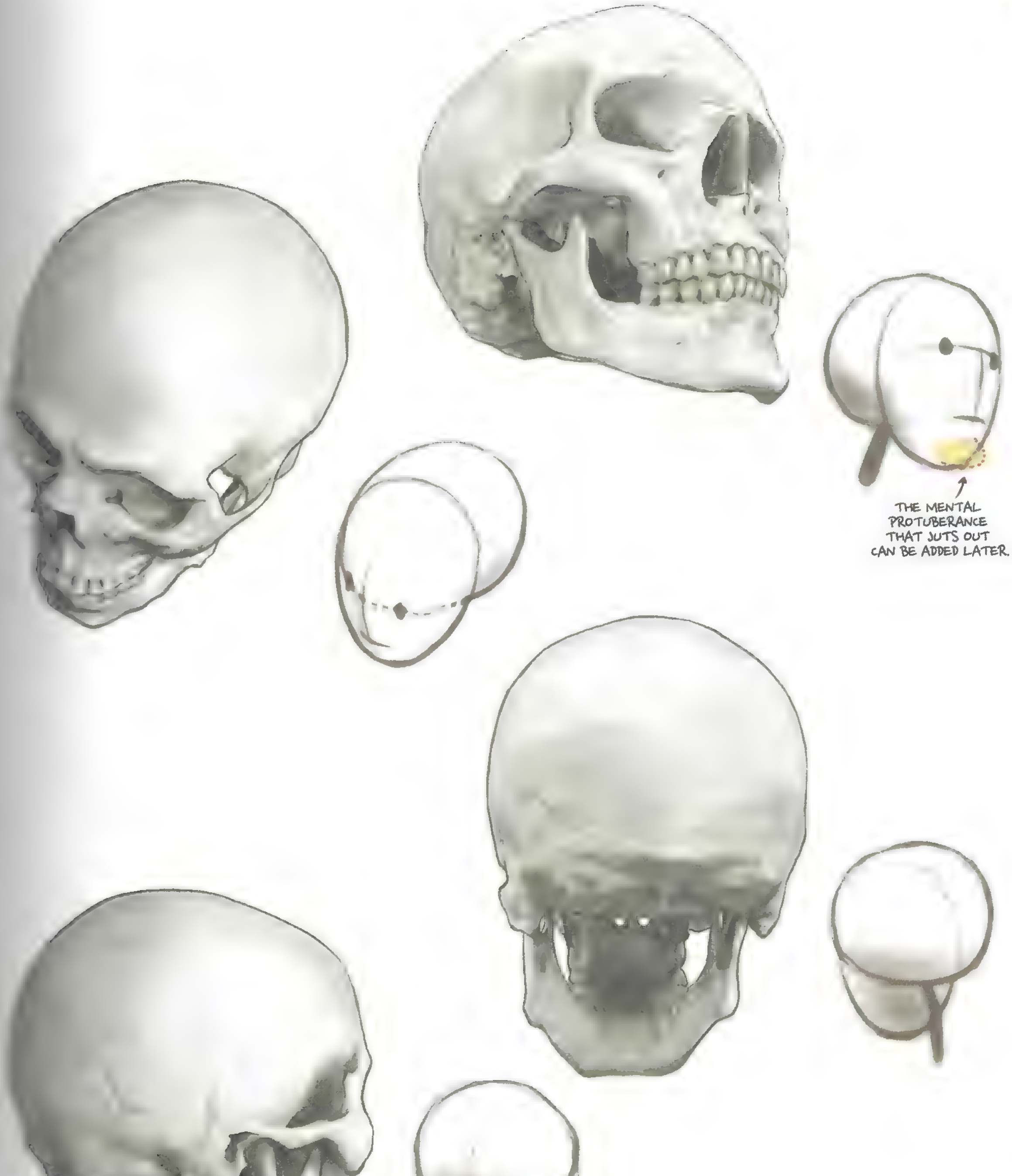
⓰ **Frontal bone:** This broad bone forms the forehead.

The skull parts that can be seen from the back view of the skull are ⑤external occipital protuberance and ⑥ mastoid. The back view of the skull is simple compared to the front and side views, so I will skip detailed explanations, but refer to the next section on how to draw the back of the skull.

■The Skull from Various Angles

Below are pictures of the skull seen from various angles. The small drawings on the right are simplified versions drawn using oval-shaped circles. This simplified version is often used for drawing a realistic head, to practice drawing the skull from many different angles. See below to learn how the skull drawing can be simplified.

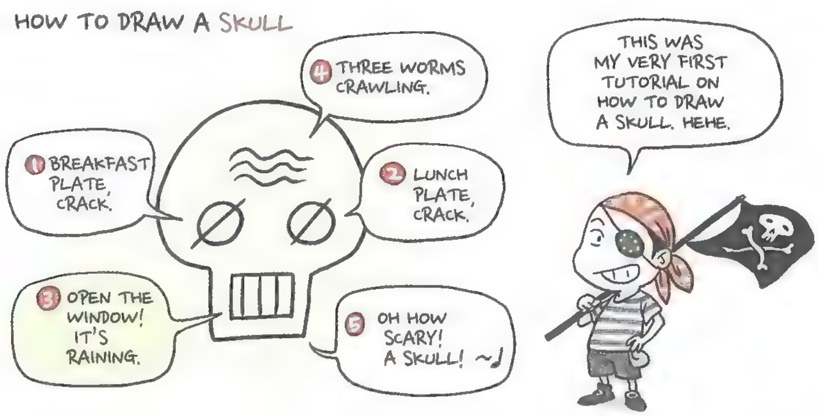



THE MENTAL PROTUBERANCE THAT JUTS OUT CAN BE ADDED LATER.
CERVICAL VERTEBRAE

Let's Draw the Skull

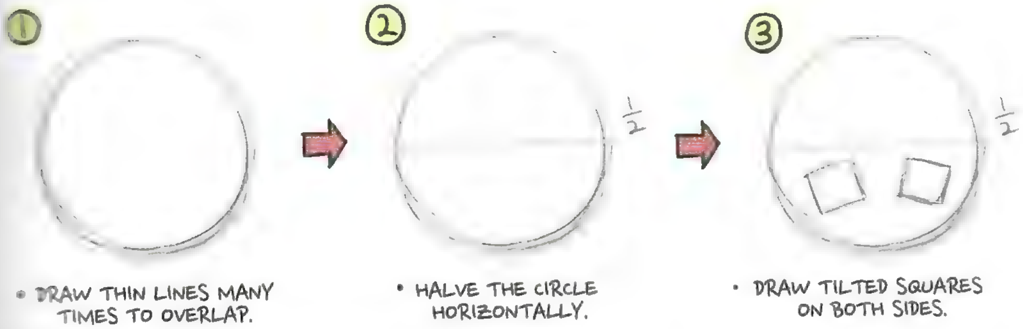
■ Drawing the Basic Shape of the Skull

So far, we learned many things about the skull. However, reading about the skull many times is nowhere as effective as actually drawing it. So now we will draw the skull. Before we start, I want to share with you a song I used to sing as a child.

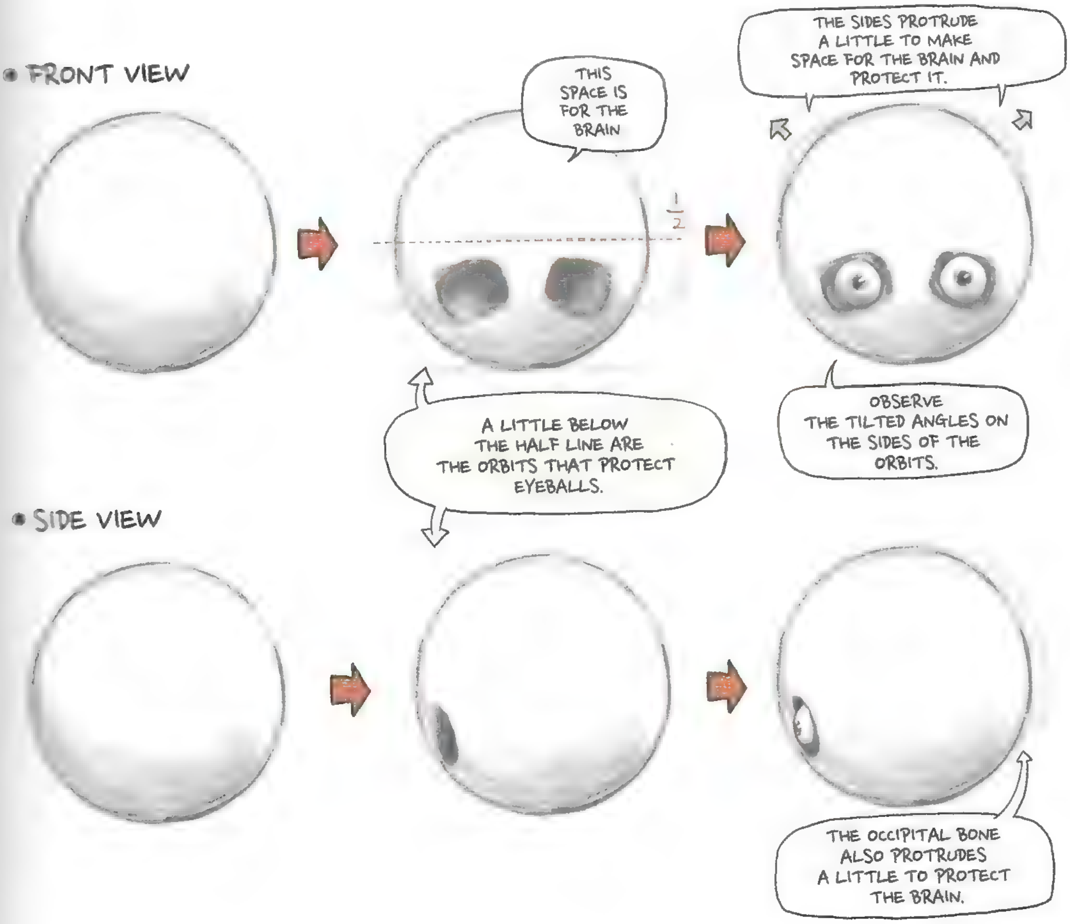


I remember how I drew rudimentary looking skulls while humming this song. Just because the drawing is simple doesn't mean that it's a bad drawing. This song serves as an example of how anyone can draw if they just follow certain rules and steps.

… draw the skull all at once is very difficult. I know that. But, if I tell you to ① draw a circle, … the circle and ③ draw squares inside, it's not that difficult, right? The drawing process we are … follow is basically a repetition of these steps. You do not need to have special artistic talent.

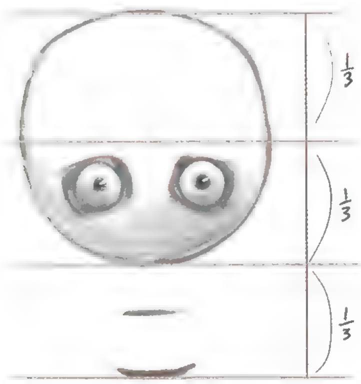


… following these simple and easy steps, you have already drawn the basic shape of the skull. … way, you can start with small steps. Now that you have taken the first step, let's continue.

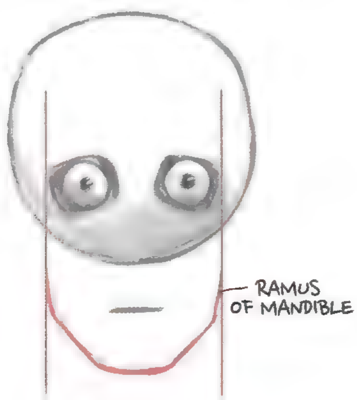


■Drawing the Front View of the Skull

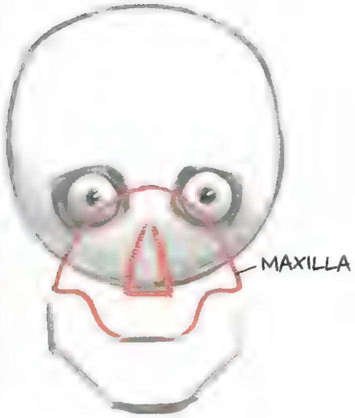
01. So, you have drawn following some steps. But so far, your drawing may not resemble a skull. That is because there is no 'jaw.' Remember that the jaw is made up of the upper jaw and lower jaw? Let's first draw the lower jaw.



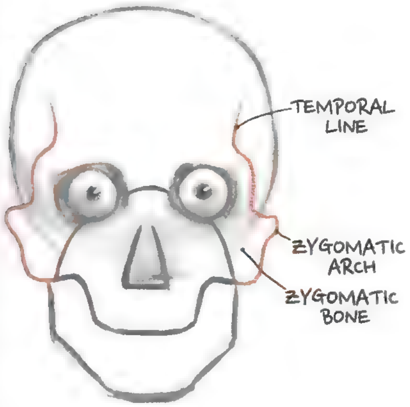
02. First, draw a reference line below the circle (cranium). The distance from the bottom of the cranium to this line should be about half the height of the circle. This is where the mental protuberance will be drawn. Draw another line between the circle and the mental protuberance line. This is where the maxilla and mandible meet. In other words, it is the reference line for lips. This will be where the upper and lower teeth meet. The lip line is actually a little above that.



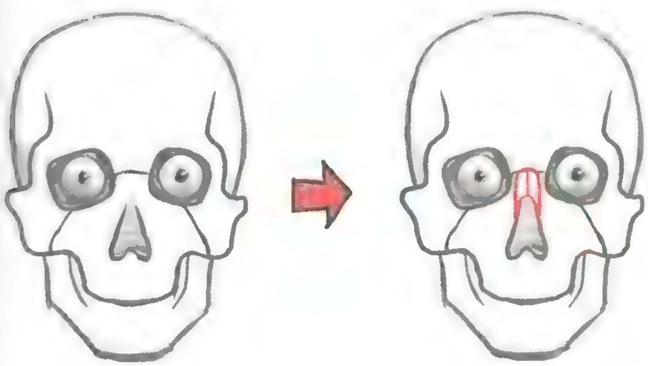
03. Starting from the outer side of the orbit, draw a line down. This is the reference line for the sides of the jaw (ramus).



04. Draw a shell shape or blunt arrow shape that starts from between the orbits to the reference line for the lips. This is the maxilla. In the middle of it, there will be the nasal cavity.



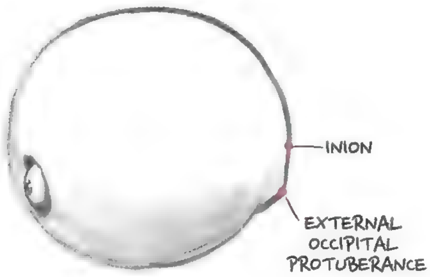
05. Draw the temporal line and zygomatic arch that start from above the orbit and continue towards the outside of the orbit. The zygomatic bone is between the zygomatic arch and maxilla.



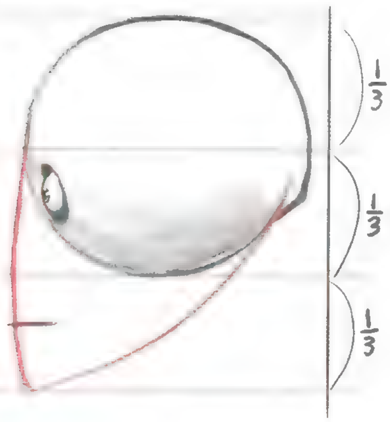
06. Add lines inside the mandible and draw the nasal bone to complete. Now, this looks more like a skull, right? It looks like the skull has a smile.

■Drawing the Side View of the Skull

Now let's draw the side view of the skull. We will start by drawing the same circle we drew for the front view.

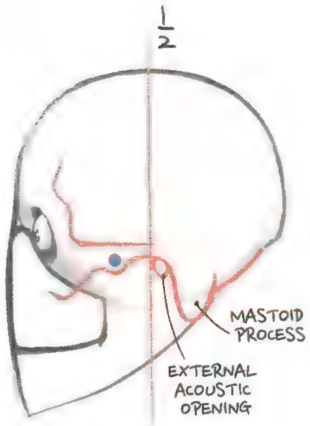


01. The circle for the side view is not really a perfect circle. The top and bottom are slightly flat making it more of an oval. This is due to the inion and external occipital protuberance that project from the back of the skull. The external occipital protuberance is where the trapezius starts.

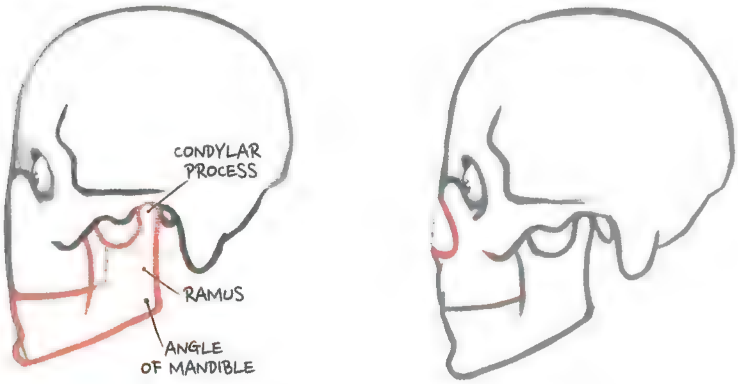


02. In the same way that we did in step two for the front view of the skull, draw lines that divide the length of the drawing into thirds. Draw something like a cone towards the front bottom. At the bottom one third, mark a line at the half point where the upper and lower teeth meet.

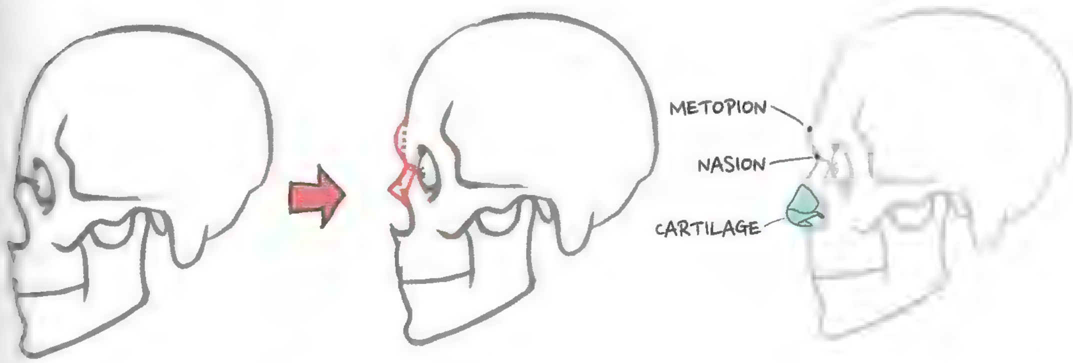
03. As shown in the drawing, connect the half point line where the upper and lower teeth meet and the reference line of the cone. This will form the maxilla.



04. Draw a reference line vertically in the middle of the circle. Draw the temporal line, zygomatic arch, external acoustic opening, and mastoid process in the respective order. Take note of the curve in the middle of zygomatic arch (blue dot). This is where the condylar process (refer to the next picture) is located.



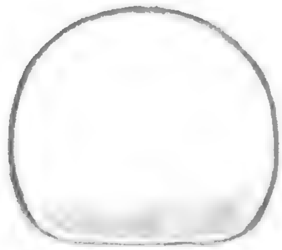
05. Draw the mandible. The mandible covers the maxilla a little. Remember that the mental protuberance and angle of mandible have to protrude. Once you draw the piriform aperture in the maxilla, you will have a pretty realistic skull.



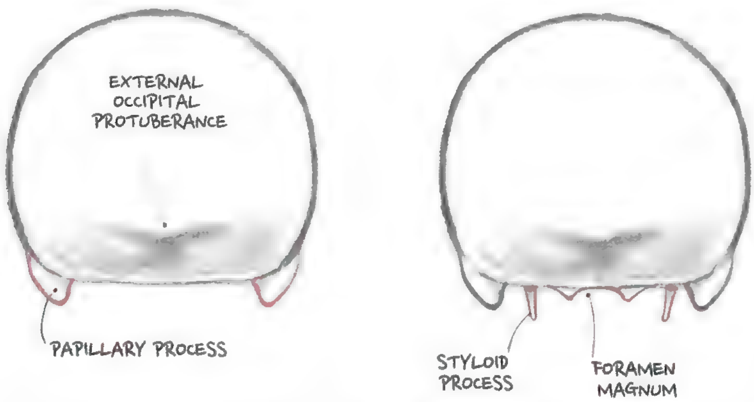
06. Draw the metopion that protrudes due to the frontal eminence (frontal sinus) and the depression for the nasion, and you will have completed the side view of the skull. As I explained before, the cartilage covering the piriform aperture supports breathing and mitigates external impact.

■Drawing the Back of the Skull

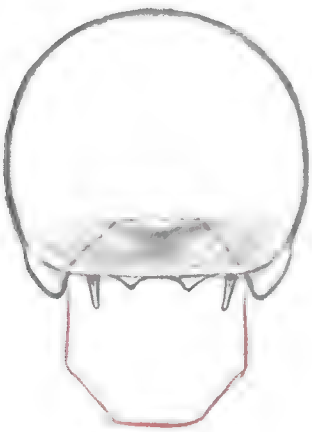
Now let's draw the back of the skull. It is much simpler than the front view, so it will be a breeze.



01. Draw a circle and erase the bottom part as shown in the picture. This will be the neurocranium that surrounds the brain, seen from the back.

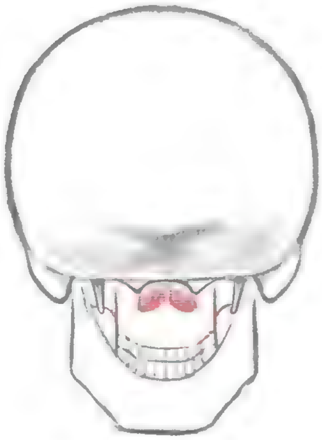


02. At the bottom back of the skull is the external occipital protuberance, this is where the trapezius starts. Also present are the papillary processes on each side. The sternocleidomastoid has an insertion here. Draw the styloid process and foramen magnum.

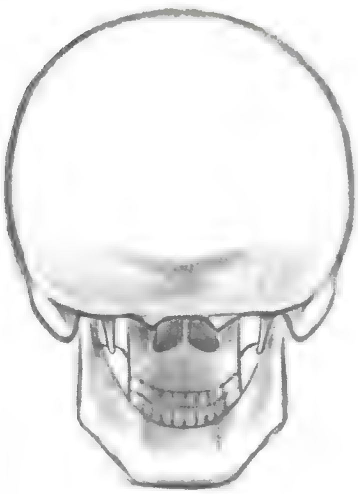


03. Now let's draw the mandible of the viscerocranium that is at the front of the skull. First, draw an octagon that overlaps with the skull. This is the frame for the mandi

04. Draw the letter U with a wide opening. This will be the reference line for the mandible.



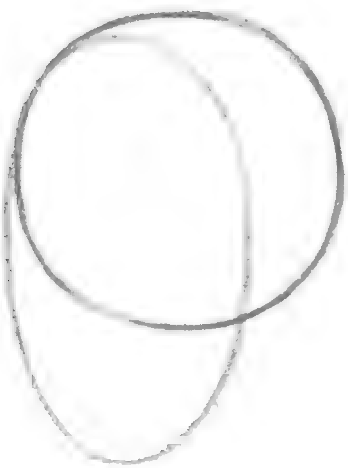
05. Draw two lines (they look like the number 11) for the maxilla. Draw the teeth in between, and then draw the piriform aperture and the zygomatic bone. The back view of the skull is almost complete.

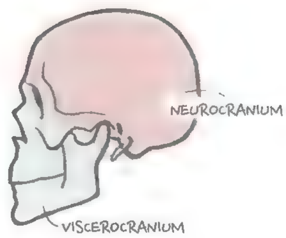


06. As shown in this example, add shading to make the skull look more dimensional.

Drawing a Dimensional Skull

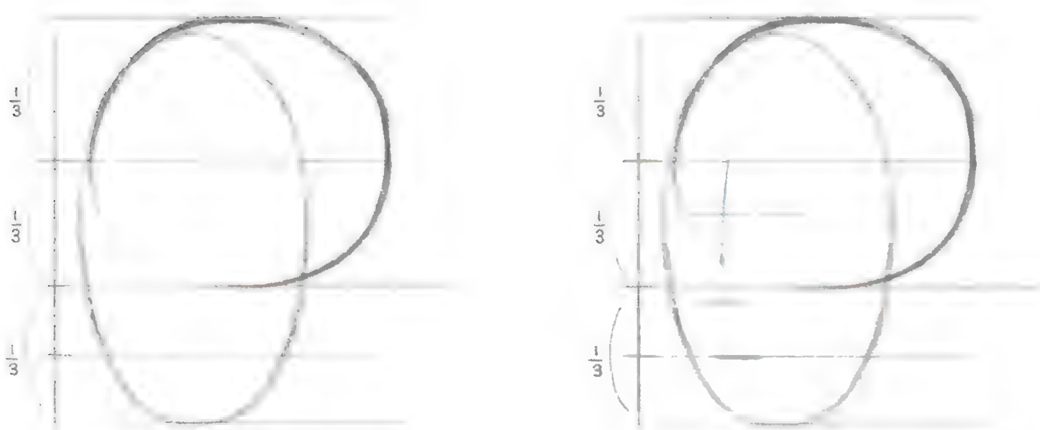
We will take a step further beyond drawing a schematic skull. This time let's draw a more realistic sk A dimensional drawing requires slightly more drawing skill and imagination. But the purpose of this exercise is not to draw a masterpiece, but to gain a better understanding of the skull, so jump in wi light heart.



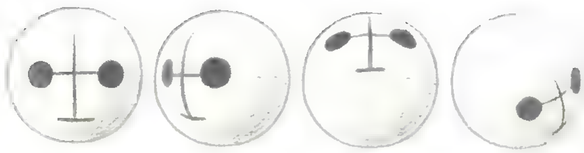


01. To draw a simplified version of the dimensional skull, st by drawing the frame of the skull by two, overlapping oval circles.

The oval on top is the neurocranium and the oval on the left the viscerocranium. The neurocranium should be a wide ov but here it looks more like a circle because we are drawing skull from a slightly front angle.



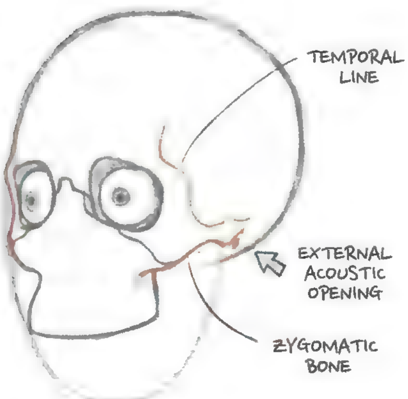
02. In the same way as before, divide the length into three parts. Draw crosses as placeholders for the eyes, nose, mouth and ears. Take note that the crosses should change depending on the rotational angle of the face. Refer to the next page.



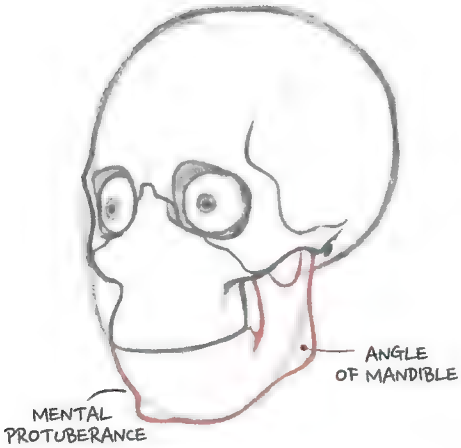
03. Draw the orbits and the eyeballs inside. The face is not a flat surface, but more of a curve. Therefore, the left eye orbit will appear flatter than the right one (refer to the pictures above).

From here on, we will start to erase the parts where the ovals and reference lines we drew for ratio overlap.

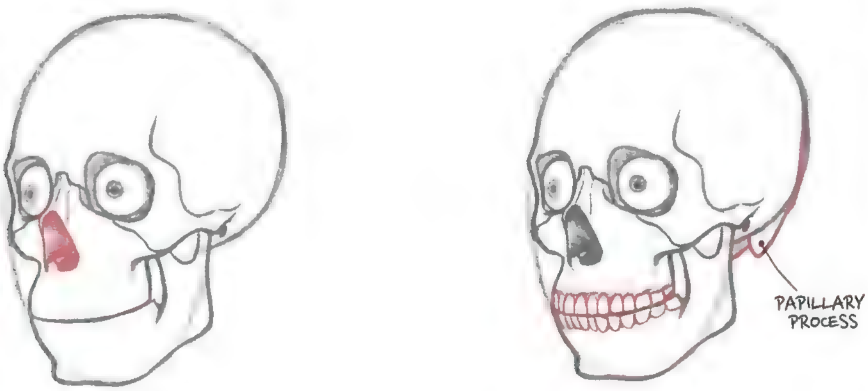
04. Draw the maxilla, starting from the middle of the orbits to the reference line for the mouth. The maxilla seen from a 45 degree angle is an irregular shape with many small curves, so it is difficult to draw. Instead of trying to complete it on the first try, continue to modify as you go.



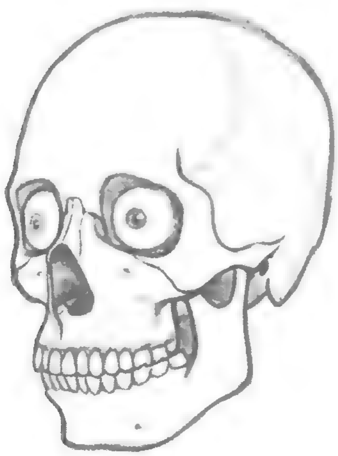
05. Draw the temporal line that starts on the outside of the orbit and flows down and the zygomatic bone line that starts in the middle of the maxilla and flows to the side. The external acoustic opening at the end of the zygomatic arch is near where the two ovals intersect. Mark a dot here.



06. Now it is time to draw the mandible. Draw the mandible following the reference line. The point is to draw sharp angles for the 'angle of mandible' and 'mental protuberance.'



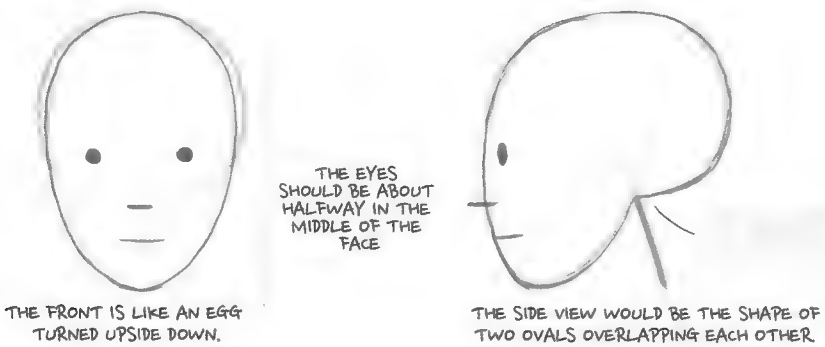
07. At the center of the maxilla, draw the nasal bone and piriform aperture. Then draw the teeth where the maxilla and mandible meet. Draw the papillary process located behind the external acoustic opening, and we have almost completed the drawing.



08. Erase the reference lines, and draw suture lines on the skull, and you will have a realistic looking skull.

Simplifying the Skull

...we have learned to draw the skull from various angles. But in the end, if we really simplify the ...it would look like the pictures below. This is how we prepare an outline when drawing comic characters or illustrations.



Front view: From the front, the viscerocranium will be more visible than the neurocranium that protects the brain. Simplified, it looks like an upside down egg.

Side view: The side view is slightly different. The face part and the back of head part are drawn as two oval shapes that overlap. At the back of the head around the level of the eyes, are the occipital lobe of the brain as well as the cerebellum which is in charge of motor control and the central nervous system that continues to the body.

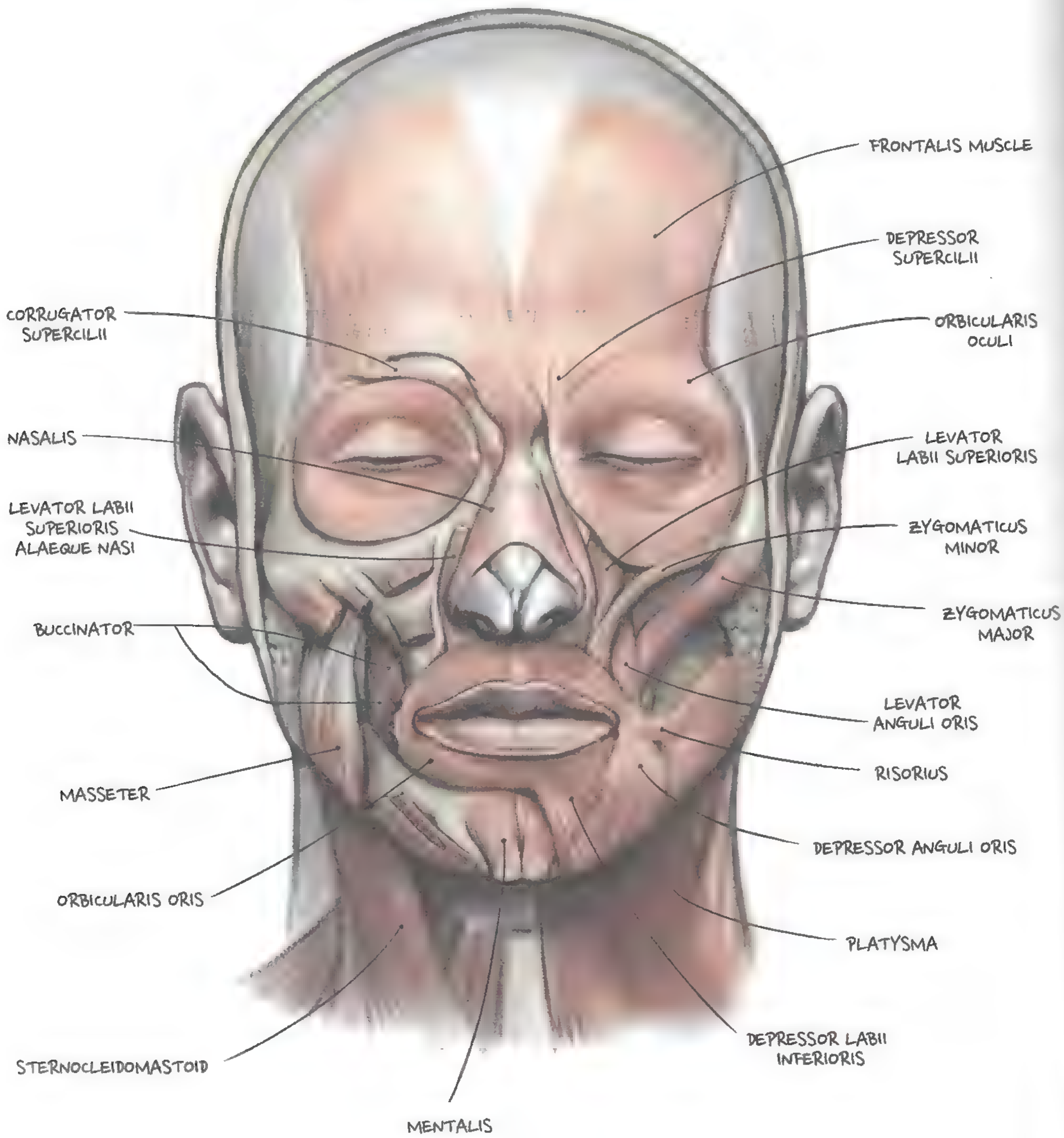
...uld like to emphasize once again that the ratio of the skull shown in the examples are based ...average' measurements. The facial ratio can differ depending on sex, age, race etc. so there ...no need to stick with one ratio only. However, having a 'base shape' or 'reference' to work with ...be a helpful starting point that you can experiment with to create variations and come up with ...erse characters. In other words, you need to start with a 'base' shape to make any 'transformation' possible.

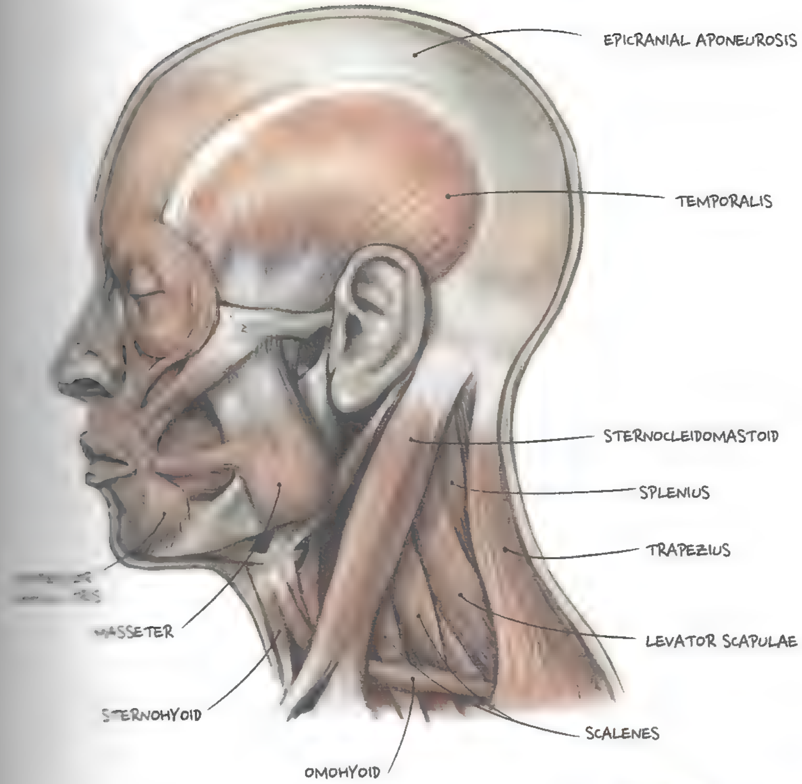
So now you have gained a better understanding of why our faces look the way they do. That is why we, our family and friends, look the way we do.

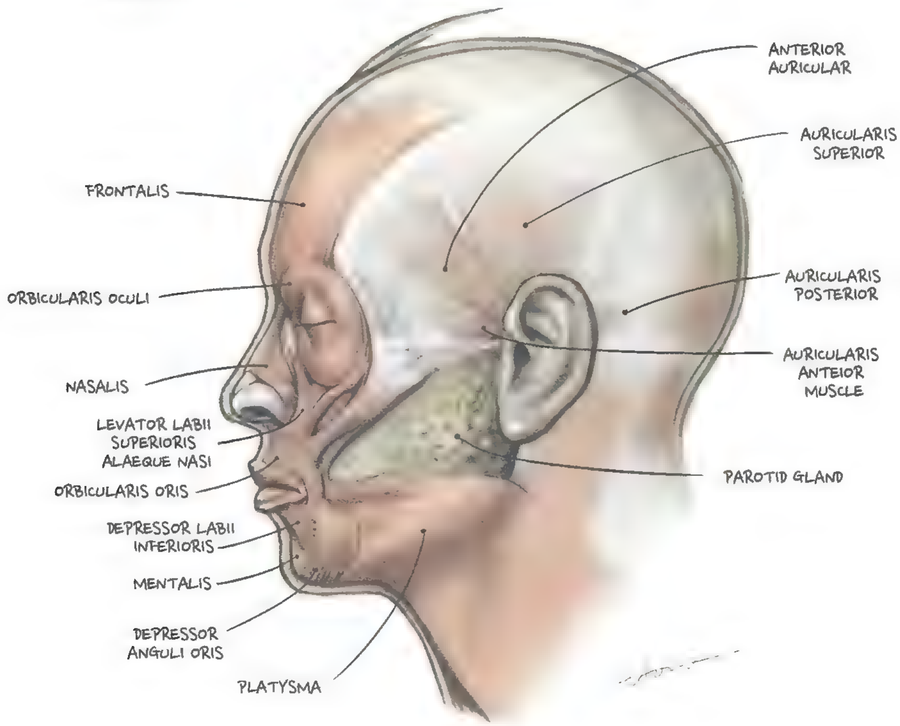
Facial Muscles

■The Major Facial Muscles

Below is an overall diagram of the head and facial muscles and their names. Unlike how we approached the bone structure, we will first look at what the muscles look like and learn some facts about the major muscles. You don't need to memorize all the names right now, so take time to just observe them.

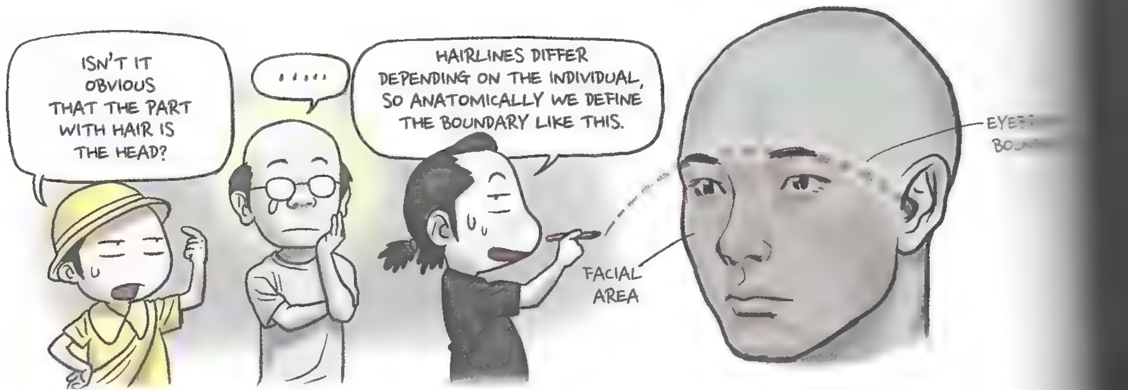



EPICRANIAL APONEUROSIS
TEMPORALIS
STERNOCLEIDOMASTOID
SPLENIUS
TRAPEZIUS
LEVATOR SCAPULAE
SCALENES
OMOHYOID
STERNOHYOID
MASSETER

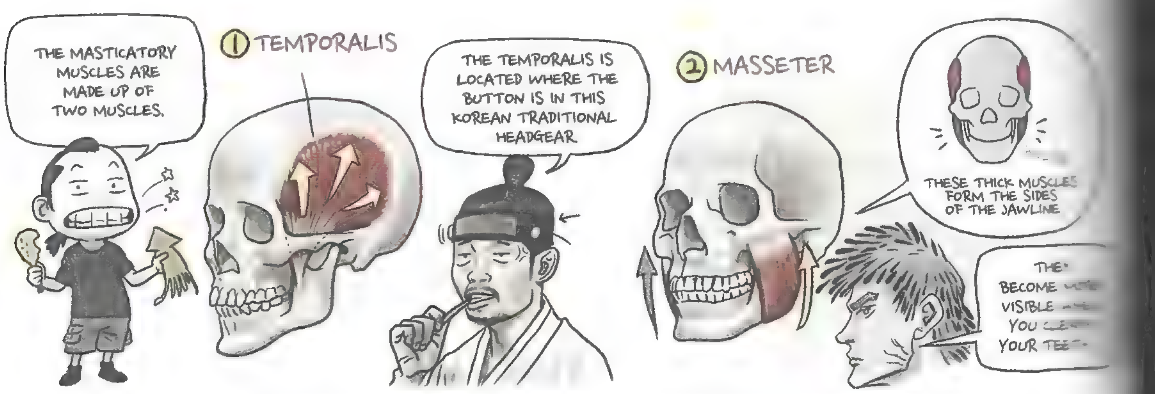

ANTERIOR AURICULAR
AURICULARIS SUPERIOR
FRONTALIS
ORBICULARIS OCULI
AURICULARIS POSTERIOR
AURICULARIS ANTEIOR MUSCLE
NASALIS
LEVATOR LABII SUPERIORIS ALAEQUE NASI
PAROTID GLAND
ORBICULARIS ORIS
DEPRESSOR LABII INFERIORIS
MENTALIS
DEPRESSOR ANGULI ORIS
PLATYSMA

■Making Faces

Before we start, I have a small question for you. Which part of the head is our 'face' and which p... the 'head'? Of course, we roughly know where they are thanks to our hair, but what about people ... are bald or who have shaven off their hair?

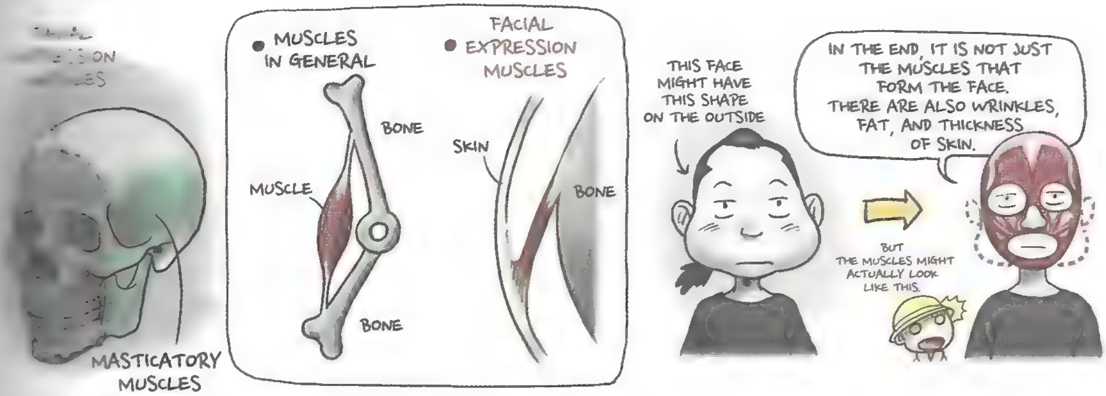


This boundary separates the head and face based on the 'outer appearance.' But from a musc... function perspective, the head and face are not independent from each other. In fact, facial mus... work in conjunction with the head muscles. The head muscles are largely divided into two parts... first are the masticatory muscles that move the mandible for chewing. They pull up the mandible which is the only facial bone that moves. As this requires a lot of strength, the muscles are thick a... affects how the face looks from the front.



The temporalis contracts and relaxes when chewing something tough.

... muscles are 'facial expression muscles.' These muscles are unique because in order to ... various expressions the muscles are inserted into the skin and not bones. In other words, these ... move the skin and not the bones, so they are thin. Since they are thin, they do not influence ... appearance. In other words, muscles do not have much to do with good looks; it is the bone ... that is more important.



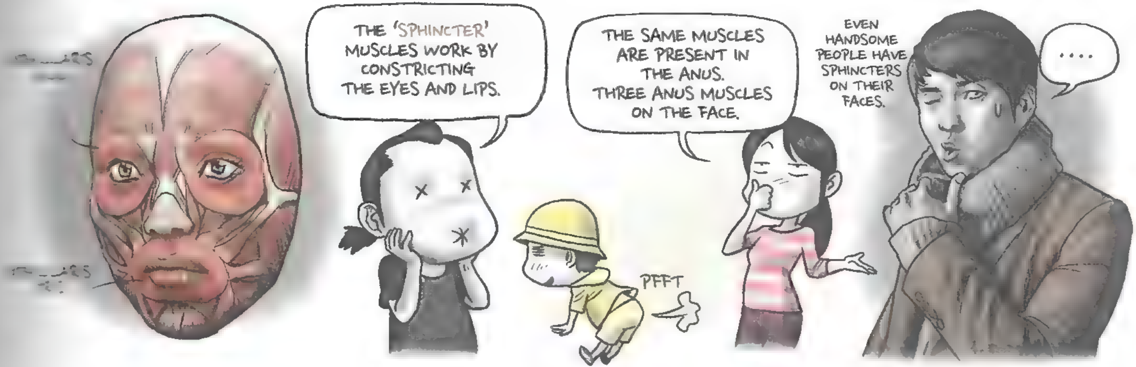
... strange that 'facial expression muscles' do not directly affect how a person looks? The facial ... muscles might not influence the basic shape of the face, but it affects 'expressions.' Also, ... grow fast unlike the bone, tendon and ligaments and can be restored quickly after damage, ... depending on the frequency of usage and training the outer appearance can change ... within a short time. Muscles become slim with more use. This characteristic also applies to ... muscles.

In the end, facial expression muscles are still muscles. They develop and adapt fast to a person's lifestyle or actions so that the person can make necessary expressions quickly. The facial muscle developed by each individual in the end create the overall 'impression' of the person. 'Physiogno is based on this fact.

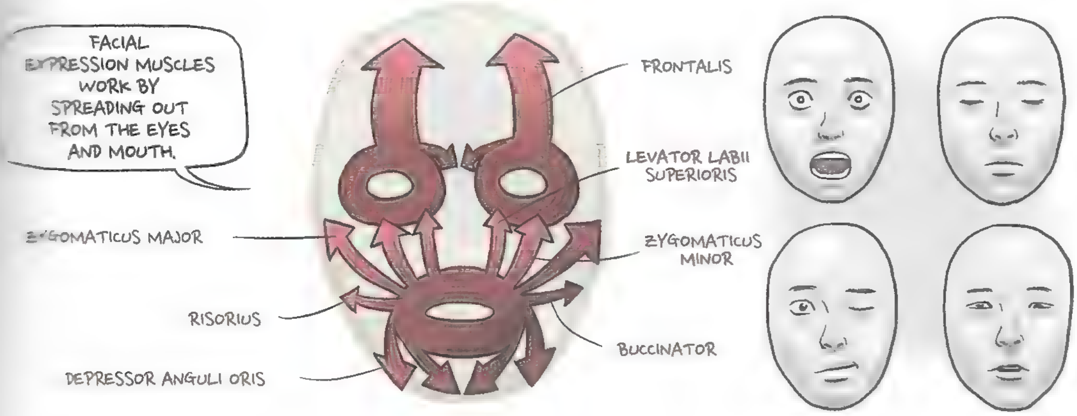
People whose occupation is to fight will develop faces that are adjusted for fighting. Because being able to intimidate the opposition with a fearsome face is advantageous.

You might think that 'expressions' that show emotions are only unique to humans, but they are just physiological functions developed to help you respond to surrounding situations fast. Over a long period of time, humans realized that these expressions represent something and that they can be used for social interactions. Thus, they began to use expressions as tools for communication.

... a facial expression is made, the most noticeable features are made with the orbicularis ocu... ...bicularis oris, which are the circular muscles surrounding the eyes and mouth. These muscles ...called sphincters. Unlike other muscles that become shorter when they contract, sphincters ...en. Thanks to this muscle, you can close your eyes and pout your lips.



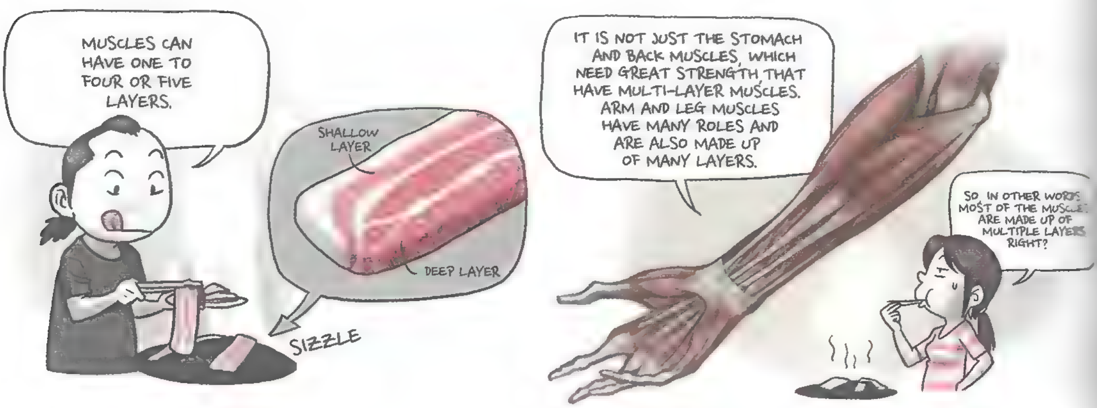
...al expressions are created when the orbicularis oculi and orbicularis oris muscles spread out ...ferent directions. They open the eyes wide or pull the mouth in various directions. That is why ...ing the eyes and opening and closing the mouth are important movements for the face. It also ...ains why these movements get the most attention. A combination of the movement of these two ...les alone can create many expressions.



Adding Muscles to the Face

Now we will take each of the muscles that we learned about and add them to the bone structure. As I have already mentioned, there are three times more muscles (650) in the human body compared to bones (204). Muscles are a source of fear to students studying anatomy. Apart from their various shapes, having to memorize all of their names is no easy task. I understand this pain.

But one thing to be relieved about is that unless you are a medical student you don't need to memorize all 650 muscles. In fact, it is sufficient for art students to know the 30-50 muscles in the outer layer. However, starting from the next page I will be introducing some 'deep layer' muscles. Although they might not seem important from a drawing perspective, they can still have importance from a 'movement' perspective and sometimes affect the shape of the shallow layer muscles.



Unlike the steps we took to draw the skull, in the muscle section we will proceed by adding the muscles one by one to the bone structure we drew before. Muscles are difficult to draw because unlike bones there are multiple layers and you cannot draw layers on top of each other. So, think of the activity such as taking pieces of clay and adding them to the bone structure little by little. If you can use programs such as Photoshop or Painter, another good way to draw muscles would be to use the layer functionality in these programs to draw each layer of the muscle.

Although muscles create facial expressions, their shape do not really indicate what the face looks like and the muscles themselves do not give any clue of the expression.
Despite this we should learn about muscles not because we are going to do a sculpture, or restore remains, or do 3D modeling, but because being aware of the source of expression can provide a lot of inspiration.

So I will bring out the skull that we drew before. I colored it with background color to be able to add on muscles.

● Skull

Divided into the 'neurocranium' that forms the head and 'viscerocranium' that forms the face (refer to page 110)

01. Temporalis

Raises the mandible. Assists the masseter to masticate.

02. Masseter

Raises the mandible. Primary muscle to masticate.

03. Corrugator supercilii, Nasal septal cartilage

Narrows the eyes.

04. Frontalis

Raises the whole eyebrows and moves the scalp.

05. Auricularis anterior, auricularis superior

Muscles that move the ears. Although not visible from this angle, the auricularis posterior is also involved. This muscle is more developed in animals.

06. Nasal cartilages, ears

For further explanation refer to page 92, 86p

07. Procerus, nasalis, depressor septi

Procerus: forms horizontal wrinkles on the glabella.

08. Nasalis

Pulls the alas to the nasal septum to flare the nostrils.

09. Orbicularis oris

Pulls the lips together into a pout.

10. Lips

- Refer to page 91.

11. Mentalis

Pushes the lower lips out and pulls down.

12. Depressor labii inferioris

Pulls the lower lips to the sides.

13. Buccinator

Narrows the cheeks.

14. Levator anguli oris

Raises the lip corners.

15. Risorius

Pulls the lip corners to the side.

16. Depressor anguli oris

Pulls down the lip corners.

17. Zygomaticus minor, zygomaticus major

Pulls the lip corners towards the cheekbone.

18. Levator labii superioris

Pulls up the upper lip.

19. Levator labii superioris alaque nasi

... up the upper lip and nose.

20. Eyeball

21. Orbicularis oculi

Closes the eyes.

22. Depressor supercilii

... down the inner side of ... brows.

23. Facial muscles

■Various Facial Expressions

The facial expressions that require muscle movement for communications are the neutral facial expressions, positive facial expressions and negative facial expressions. Paul Ekman, a psycholo[illegible] and expert in expression categorizes human facial expression into six categories. The muscles use[illegible] for each of these expressions are as below.

Emotion	Major Muscles	Mechanism
Happiness	Zygomaticus major, orbicularis oculi	Zygomaticus major: pulls the lip corners up and side[illegible] Orbicularis oculi: raises the cheeks and narrows the e[illegible]
Sadness	Frontalis, corrugator supercilii, mentalis, depressor labii inferioris	Frontalis, corrugator supercilii: forms wrinkles in the middle of the forehead. Mentalis, depressor labii inferioris: pulls the lips do[illegible]
Disgust	Nasalis, levator labii superioris alaeque nasi, levator labii superioris	Nasalis: forms wrinkles around the nose. Levator labii superioris alaeque nasi, levator labii super[illegible] widens the nostrils, creates nasolabial folds.
Surprise	Frontalis	Frontalis: raises the eyebrows and forms wrinkles on [illegible] forehead.
Fear	Frontalis, platysma (explained later) etc.	Raises the eyebrows, upper eyelid becomes tense, lo[illegible] lips spread to the sides, pupils dilate, lips part horizo[illegible]
Anger	Depressor supercilii, nasalis, depressor anguli oris	Depressor supercilii, nasalis: pulls down the eyebrows [illegible] forms wrinkles on the nose. Depressor anguli oris: forms wrinkles around the m[illegible]

In reality, it is difficult to assume that certain expressions always lead to certain muscles contract[illegible] The expressions that we see in everyday life are very complex and may not be consistent with emotion. For example, an expression might look like 'anger' but in reality the person might be laughing, or it might be 'surprise' but in reality the person might be angry.

The following pictures are some expressions I selected. I tried these expressions myself and stud[illegible] which muscles were used (my face still hurts!) However, I did not list all of the muscles, so try guessing the muscles are not listed.


Procerus
Zygomaticus major
Corrugator supercilii
Platysma
Depressor supercilii
Depressor anguli oris
Levator labii superioris alaeque nasi
Frontalis
Orbicularis oris
Levator labii superioris
Levator anguli oris
Mentalis
Corrugator supercilii
Procerus
Zygomaticus minor
Nasalis
Levator labii superioris
Mentalis

'Woman's life' / Painter pencil brushes / 2014

IV
Torso

About the Trunk

If the head is the root, then the spinal column would be the main stem.

**This structure is the core that props the body,
and at the same time, the starting point of all movements.
The spinal column is the most important structure for survival for humans
and almost all vertebrates, because it protects life-preserving organs such as
the heart and lungs.**

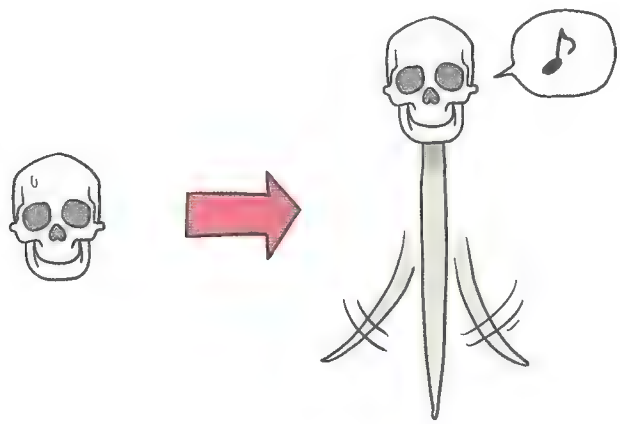
**In this chapter we will be learning about the structure of the spinal column,
and the thoracic cage and the pelvis that the spinal column is holding.**

Start of the Stem

■Basic Form of the Body

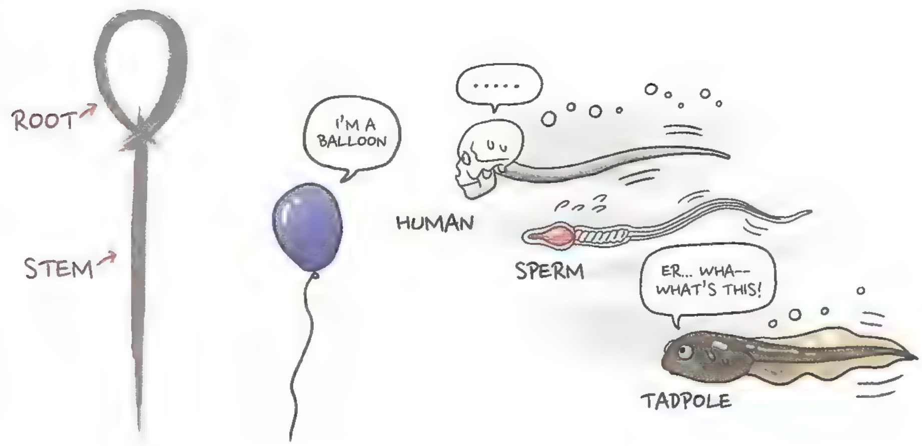
We've explored the 'skull' earlier, but we're just getting started. What's the point of having ju
head, no matter how important it may be? You can't even move. It would be hard to move u
somebody moved your head for you, and your brain wouldn't last long.

Therefore, if we were to attach the most basic device just enough to move towards the direct
that we intended, it would look something like this. It cannot get any simpler than this.



The human body starts in this simple form. It looks like a balloon tied to a thick thread when standing upright. The thick thread would be the spinal column (columna vertebralis) and animals with vertebra, the individual disc that makes up the backbone, are called vertebrates. If we think of the head as the 'root' of the body, then we can think of the 'backbone' as the 'stem.'

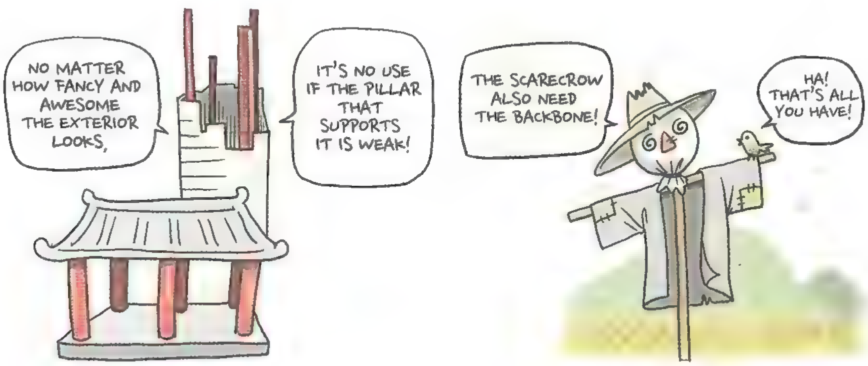
But wait, doesn't this look like something we've seen before?



That's right. We look similar to a sperm or a tadpole, like the form we were in before we are fused together with the egg, Ultimately the basic form of every vertebrate that starts from the ocean—the cradle of life—looks like this.
This is a very important subject, although it may seem like a very careless and simple concept at first glance.
Despite all the names we could've come up with, the use of 'vertebra' as part of a naming scheme for the physical characteristic of animals seems like evidence that the spinal column is important to the human body.

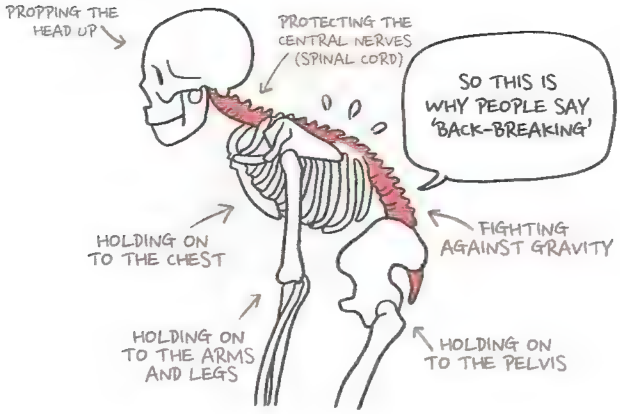
■Back-breaking Backbone

I've said the spinal column is the 'minimum required device to move the head,' but it does a more than just 'moving.' It is necessary to go over the functions of the spinal column we'll be learning from here on, because it will be very helpful to understand its form.
The second function of the spinal column besides 'moving,' is to 'support' the body, as we see from its name, 'spinal column.' The spinal column can be considered to be the 'pillar of body' because it holds in its place the shoulder, which connects the arms and the chest, and pelvis, which is the starting point for the legs, all together.



The third function of the spinal column is to transmit signals that controls movement and to protect the spinal cord. The cord transmits sensory signals from in and out of the body to the brain. Not only does the spinal cord send commands from the brain to everywhere in the body but it also has a role of a controlling reflex movements such as contraction of blood vessel and secretion of sweat and bowel movements, so it has a vital survival function.

The nervous system can be divided into the central nervous system (CNS) and peripheral nervous system (PNS).
The central nervous system is made up of the brain and the spinal cord,
and the peripheral nervous system collects exterior stimulus and transmit the signals sent from central nervous system throughout the entire body.



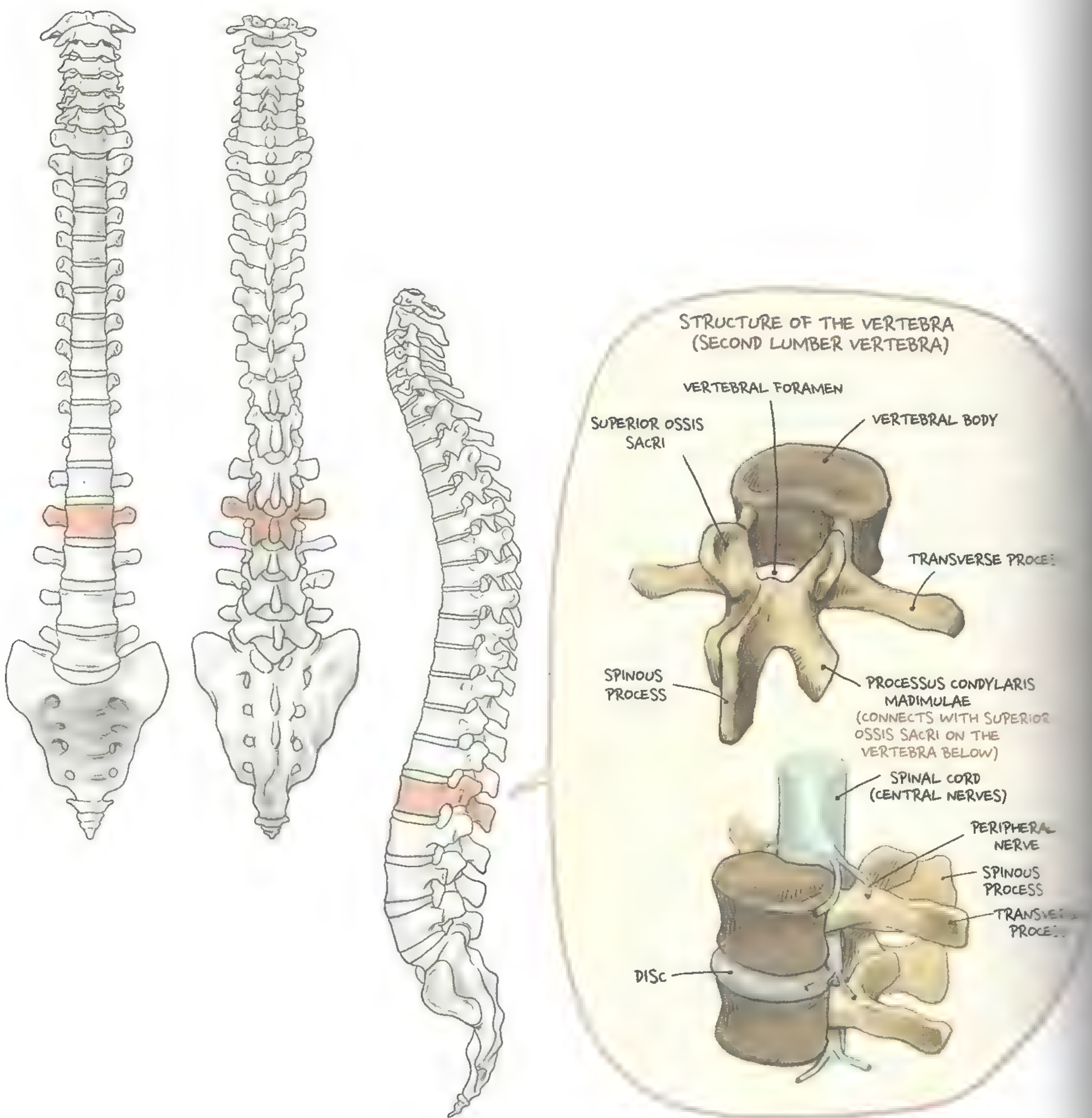
that, it also needs to hold on to the thoracic cage that protects the heart and the lungs, that's holding the legs, and the erector muscle of the spine that's propping the body to summarize the basic functions of the spinal column are movement, supporting the and protecting the spinal cord. However, if you think about it, you will come across an contradiction.

...pinal column, which 'moves the body.' is a structure that acts as a 'pillar' so it shouldn't be ...g that much. If the pillar is soft, then it would be hard to support the said body parts, but ...cannot perform its other important function, which is to protect the 'spinal cord (central ...) and would cause problems transmitting signals to the body.

...This is a major head-scratcher. What exactly does the spinal column have to be like, if the ...has to move while not moving at the same time?

At first glance it sounds like an impossible structure, but actually this is what the spinal column of primitive fish looked like, and it was called a notochord. This kind of spinal column can be still seen today in fish such as eels, and the spinal column of the vertebrate have evolved to have multiple vertebra so that it can withstand the gravity and the weight of the body.

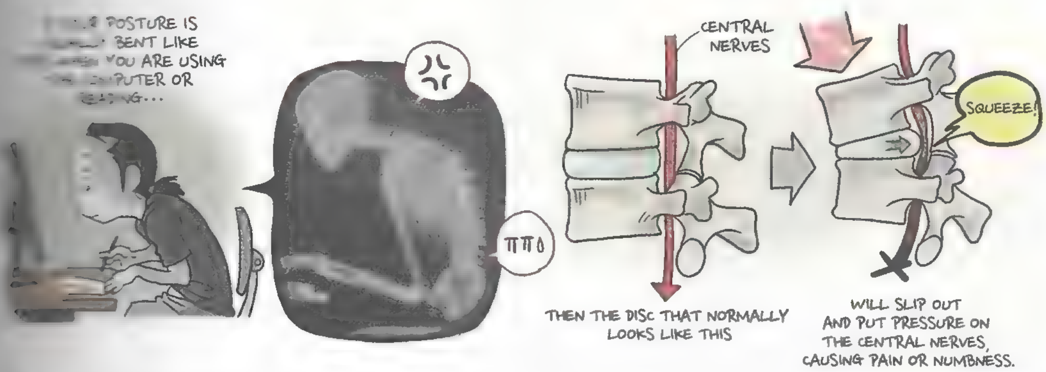
To resolve this contradiction, the spinal column is divided into 24 vertebrae, and each verte is connected by the 'cartilaginous articulation' and the 'intervertebral disc' in between (for reference, a vertebra is like an individual brick that makes up the pillar called the spinal co



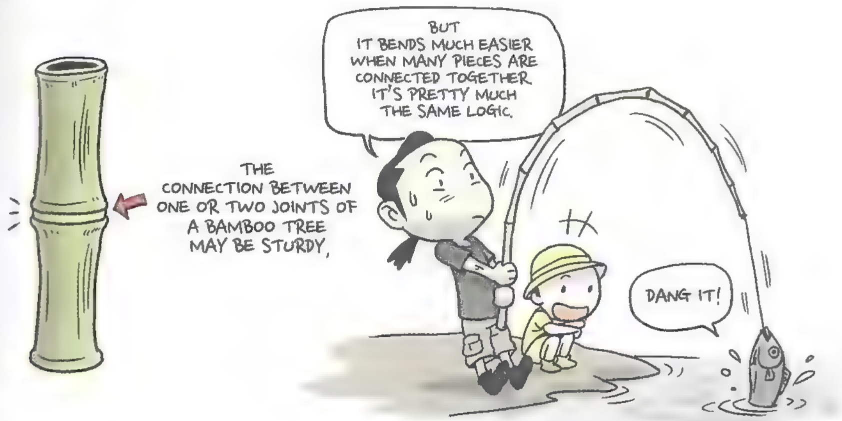
Starting from the left, the shape and the structure of the vertebra from the front, back and side view. The shape changes slightly as it goes downwards, but the overall structure is similar.

wait! Intervertebral cartilage = DISc

...ebral cartilage (disc) is made of a gelatin-like substance that not only prevents friction in ... vertebra, but also buffers the weight that the spinal column has to bear due to the nature ... body standing straight. However, if you lift heavy objects too suddenly or have a habit of ..., then the disc will be pushed out of its place and put pressure on the nerve that will prevent ... from being transmitted to the body properly. This pain or numbness in the body is an illness ... slipped disc' and structurally usually occurs on the neck and the lower back because those are ... parts that move. Therefore a 'slipped disc' is something that only occurs on humans because we ...



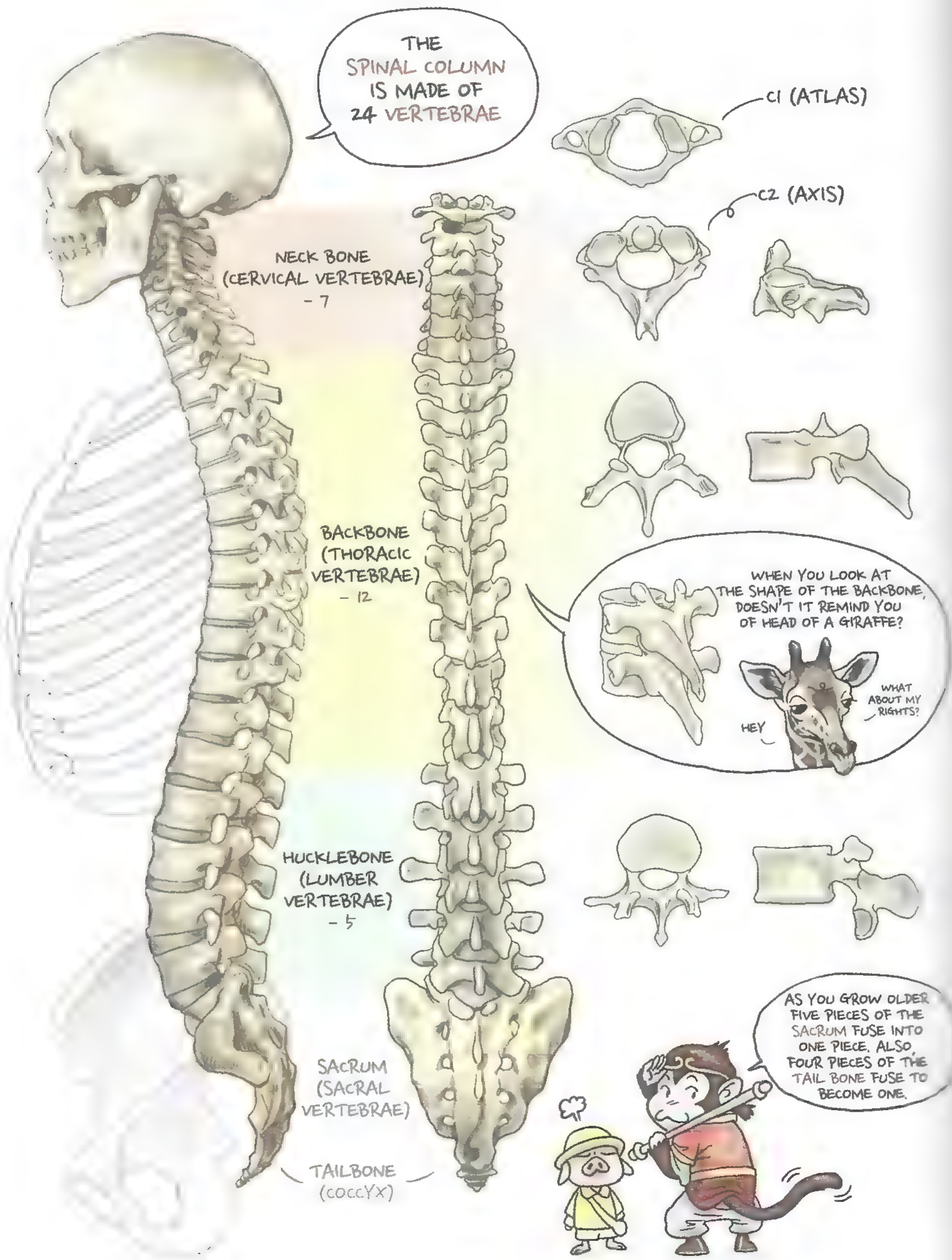
...only known nowadays, but it is said that our height is shorter during the day because the discs ... pressed against each other from everyday activity, so we usually grow more in the morning than at ...



...earlier chapter when we covered the 'joints,' I told you that 'cartilaginous articulation' ... like the 'synovial joint,' albeit not as much. Even though the individual vertebra doesn't ... as much by itself, moving smoothly becomes possible when 24 vertebrae are put ... Therefore, it is possible for the spinal column to both 'protect the spinal cord' and 'move ...dy' at the same time. The human body is just so profound and mysterious the more you ...now it.

■Units of the Spinal Column

The spinal column consists of 24 individual vertebra, and they are divided into the neck bone (cervical vertebrae – 7), the backbone (thoracic vertebrae – 12), and the hucklebone (lumba vertebrae – 5).
Usually we consider the 'spinal column' to be comprised of the neck bone, the backbone a hucklebone. However, depending on the circumstances, the spinal column can be conside to have 33~35 vertebrae by including the sacrum and the tailbone as well. Please refer to t image below.



...ck bone (cervical vertebrae)

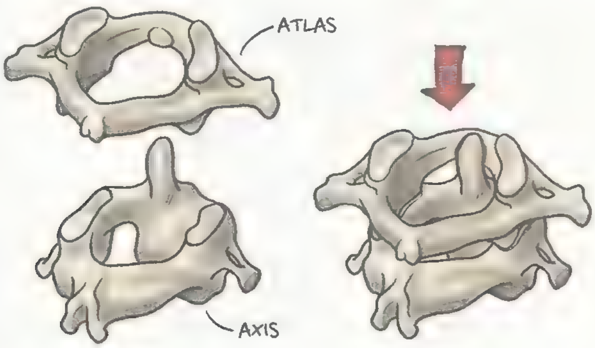
...ing for 'cervical vertebrae' is numbered with the initial letterings 'C1' to 'C7.' All ...s, regardless of the length of the neck, have 7 cervical vertebrae. The function of ... bone is to move the entire neck, and we will be going over a few of its distinctive ...stics.

...as)

...ed after Atlas, the titan of Greek myth who supported the earth, this vertebra literally supports the ... It is hidden inside the skull so it's not that visible from the outside.

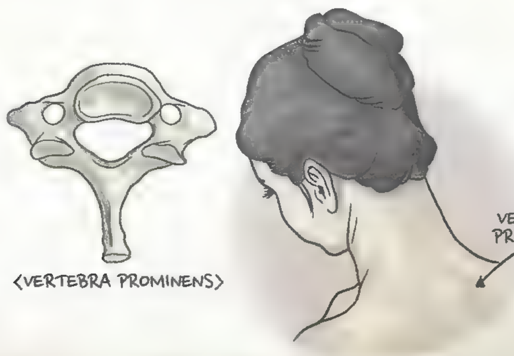
...2 axis)

...e name implies, its core function is rotational movement (please refer to the chapter on joints).



...seventh cervical vertebra, vertebra prominens)

...trudes outwards more than any other cervical vertebra because it is connected to the muscle that ...s the head upright. You can feel it when you run your hand on the back of the neck. It is also an ...rtant landmark for drawing human anatomy.



❷ Backbone (thoracic vertebrae)

The backbone consists of 12 vertebrae and is marked with the initial lettering and numbers T1 to T12, just like the cervical vertebrae. It hardly moves because it is connected to the ribs, which protects the heart and the lungs. But the 11th and 12th vertebra, which the floating ribs are connected to, moves along with the lumbar vertebrae.

❸ Hucklebone (lumbar vertebrae)

It consists of 5 vertebrae. It is marked as L1 to L5, and has the most movement along with the neck bone. It is bigger and thicker compared to the other vertebrae, because it takes on a lot of pressure from propping the upper body upright.

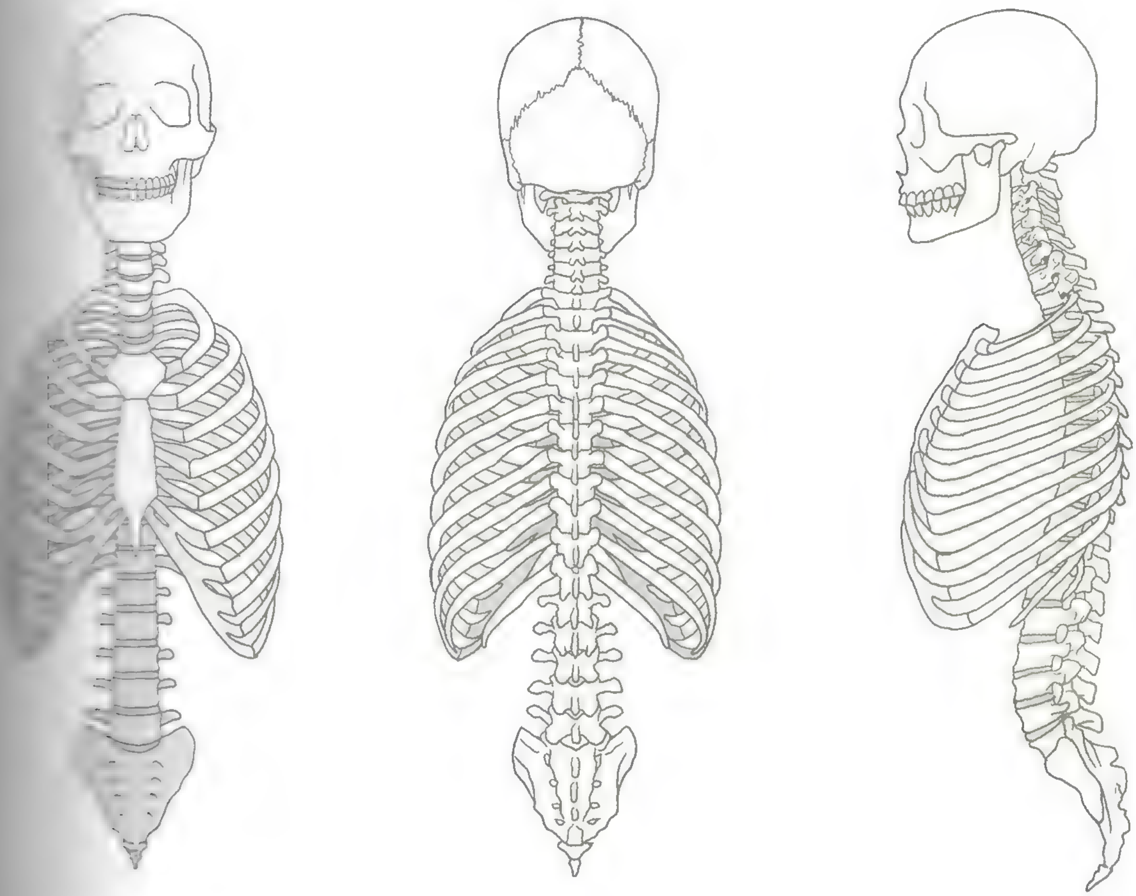
❹ Sacrum / tailbone (coccyx)

The sacrum and tailbone are considered a part of the spinal column, but we will cover this more in depth together with the 'pelvis.'

We will finish up on the spinal column for now and take a look at the thoracic cage and the pelvis, the important structures that the spinal column is holding on to. The proper form of the spinal column can only be seen when put together with the thoracic cage and the pelvis.

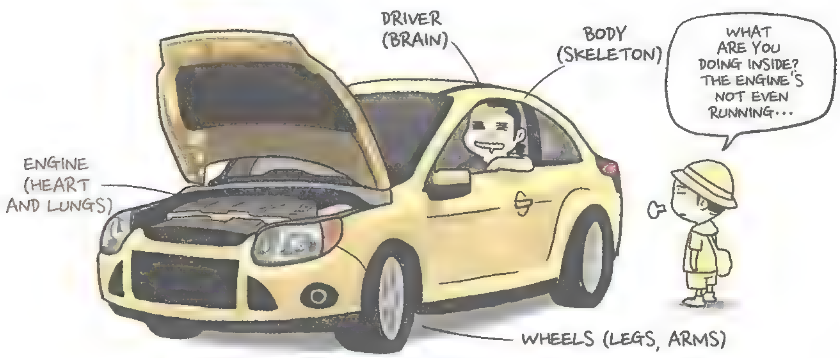
Thoracic Cage: Protector of Life

[illegible]oracic Cage, Protecting the Engine



[illegible] above is the overall shape of the thoracic cage (thorax). People often confuse 'the ribs' [illegible]racic cage,' and we'll cover them more in depth, but for now you can think of the ribs [illegible] pieces that make up the thoracic cage. It is related to the 'vertebra' and the 'spinal [illegible]

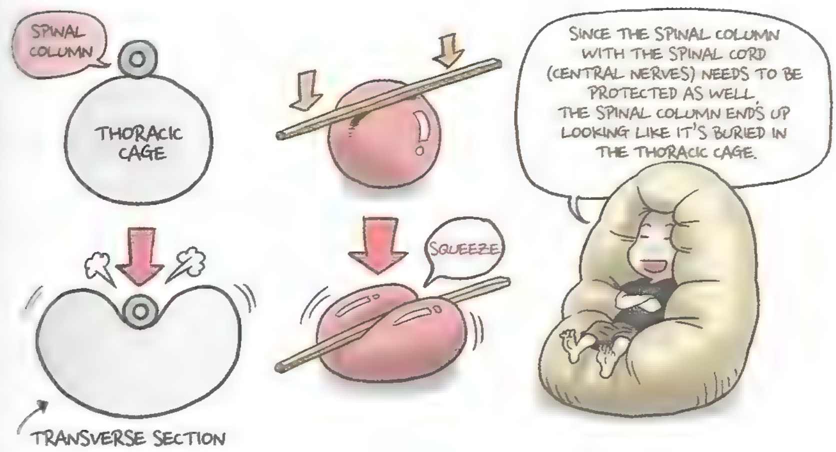
It looks complicated because it is made of several rib bones that's why we also call it the rib cage. But, it is not that hard if you first understand the 'reason for being so.' Earlier we've lea that the basic function of the spinal column is to 'move.' Then what kind of device is necess order to 'move?' Let's take a look at an automobile, which is a machine purely designed to



To be sure, the legs and arms are also essential for moving, but that would be meaningles without the 'engine' that produces power. Also, no matter how excellent the driver may be, t can't move the car if the engine won't start.
In other words, the 'heart' and the 'lungs' are the engine of the human body are just as im as the brain, as they transmit energy necessary for each part of the body to function prope that case, we would need some kind of protective barrier around this 'life preserving comp
This big, egg-shaped barrier is called the thoracic cage (thorax).
So then, what kind of shape would be most ideal for the thoracic cage?

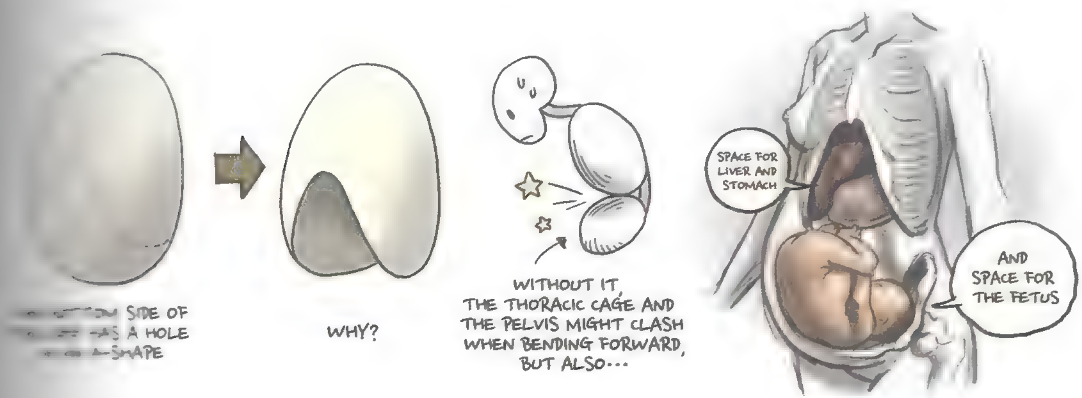
The reason why one side of the lung looks different to the other is because the heart is placed slightly to the left.

...function of the thoracic cage is to protect the heart and the lungs, but it also needs ... the spinal column on the back to protect it. Therefore the transverse section view of ... cage looks something like a chopstick pressed firmly on a round rice cake (mochi) ... of a slightly flattened heart.

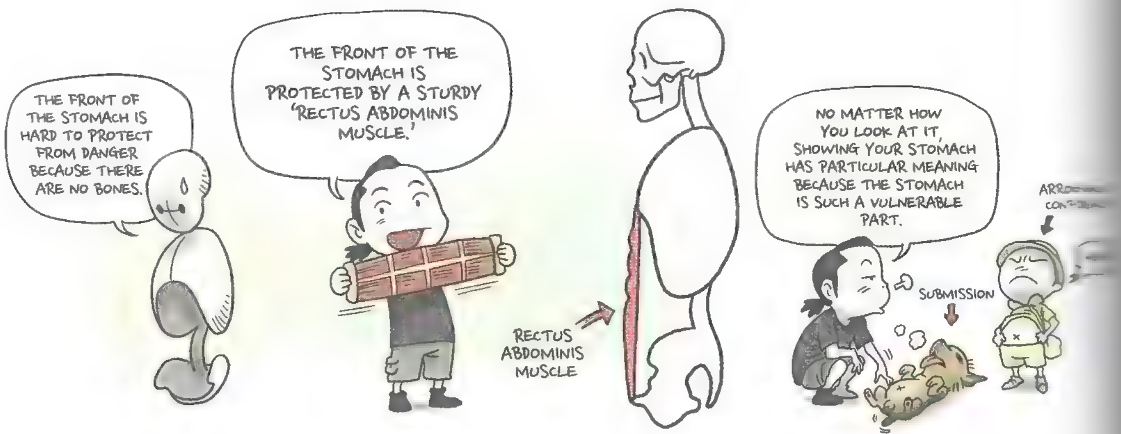


...like humans who stands upright, the transverse section view of the spinal columns of vertebrates often tend to protrude out upwards, because the thoracic cage is 'hanging' on the spinal column.

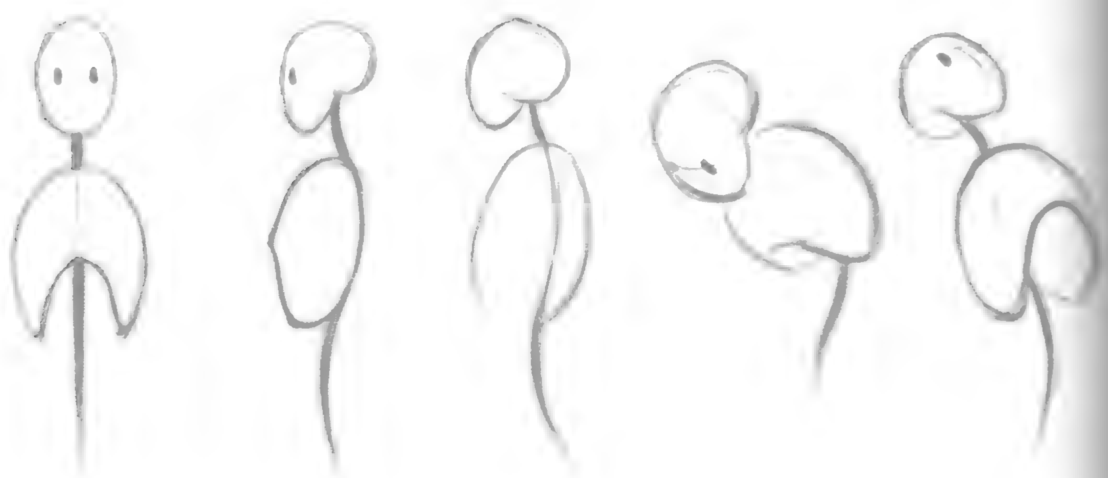
...essary for the top and the bottom part of the thoracic cage to be open. Below the heart ... lungs are the stomach which expands when consuming food. At the same time the ... expands and has endless 'peristaltic movement,' and moves to provide the space ... for the 'fetus.'



...shaped hole is called the thoracic outlet. However, there is a problem with the thoracic ... having a hole on the bottom. Unlike vertebrates that walk on four legs, humans walk while ... upright, and the stomach is exposed to external stimulus. Then what is the solution?



The 'rectus abdominis muscle' is not only a strong muscle by its own, but is covered by seve layers of strong aponeurosis, thus performing both roles of 'moving' like the muscles and of 'protecting' like the bones (please refer to p.240 for the abdominal muscle).
Therefore, illustrations of the thoracic cage in a simplified form would look something like th s

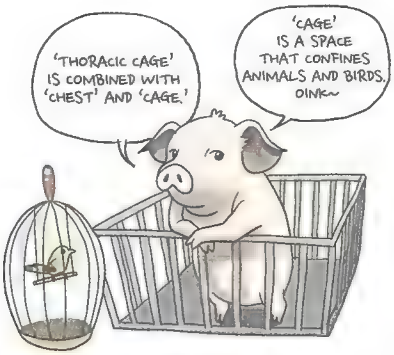


They are similar to the very basic form of vertebrates we covered earlier. Frankly, this is good enough as an illustration, but there's still something missing.

Ah yes, the 'rib bones' are missing.

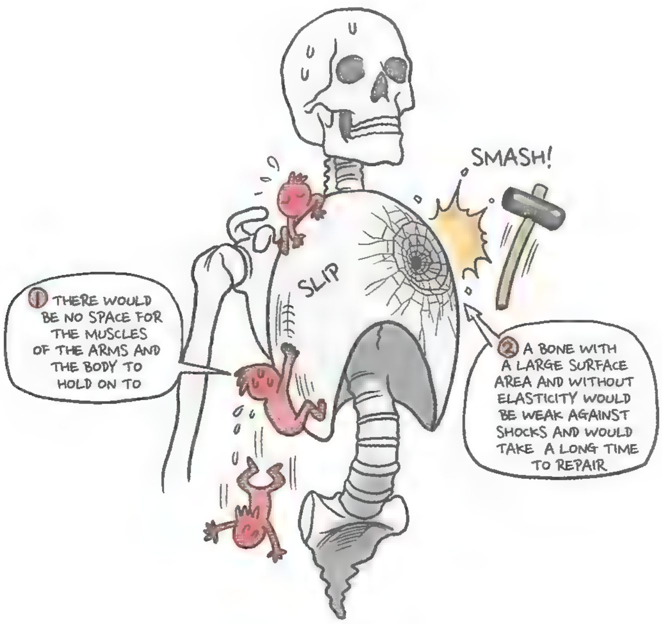
Let's Dig into the Ribs

In this section we will be going over the rib bones. They are the individual pieces that make up the 'thoracic cage.' But before we start considering the shape of the ribs, we will need to think about the most fundamental problem—the reason why it is named the 'thoracic cage.' That is because things are usually named after its form, and that form is determined by the 'functionality' of the whole structure. If we know the reason for its name, then it becomes easier to guess its shape and functions.

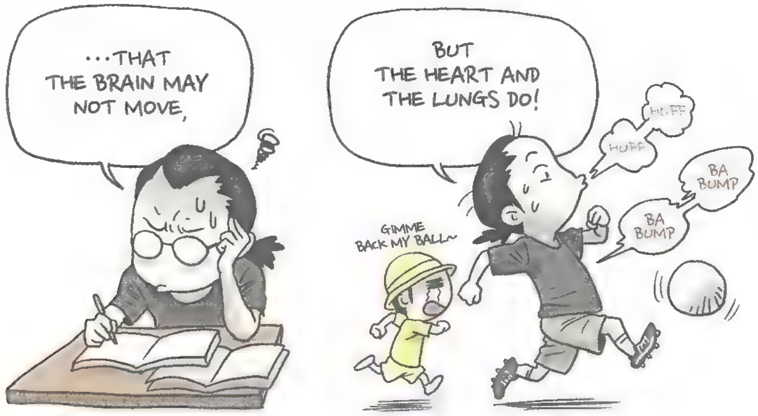


Thoracic cage' is derived from the Greek word 'thōrax' (breastplate, cuirass, mail, corselet) and combines with the word 'cage' when referring to the frame of the chest.

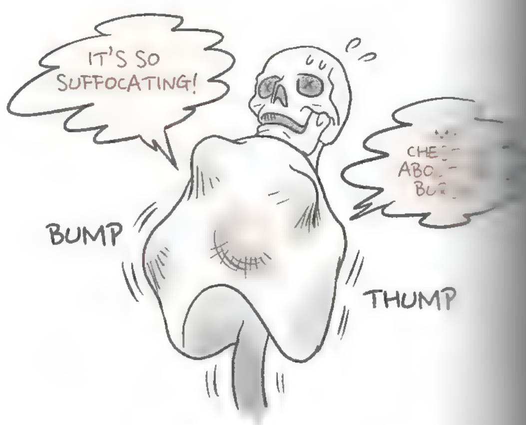
'Thoracic cage' literally means a cage that surrounds the chest—it is a structure in the shape of a 'cage' that protects the heart and the lungs. While it might seem much better if the structure was made out of a whole bone that is sturdy like the skull, it would cause the following serious problems.



Even if we were to ignore those two problems, the most critical problem would still remain. that is,



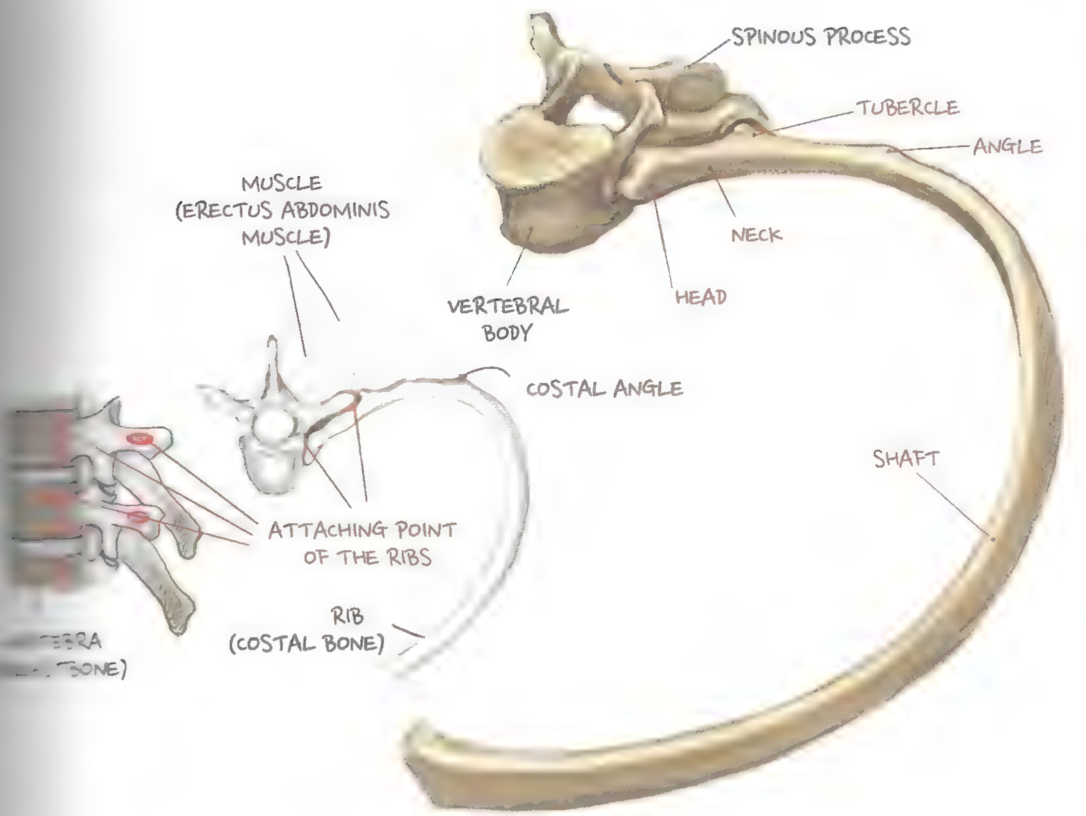
The same goes for the stomach and the digestive organs below it, but the heart and the lungs are moving endlessly from the moment we are born, so it needs to be well protected by a sturdy structure. But it would cause a problem if the thoracic cage were an oval shaped structure with the surroundings closed up like the skull.



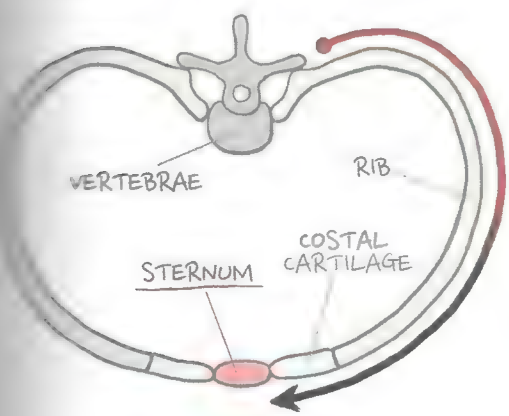
In other words, if the inside organs are moving, then the cover that wraps around those organs must also be fluid.
To summarize, a thoracic cage;

1. **Aids respiratory movement of the heart and the lungs**
2. **Functions like a 'ladder' for the muscles to hold on to**
3. **Needs to consist of several elastic bones that can absorb external shocks.**

That is why we refer to the bones that make up the thoracic cage as 'rib bones.'



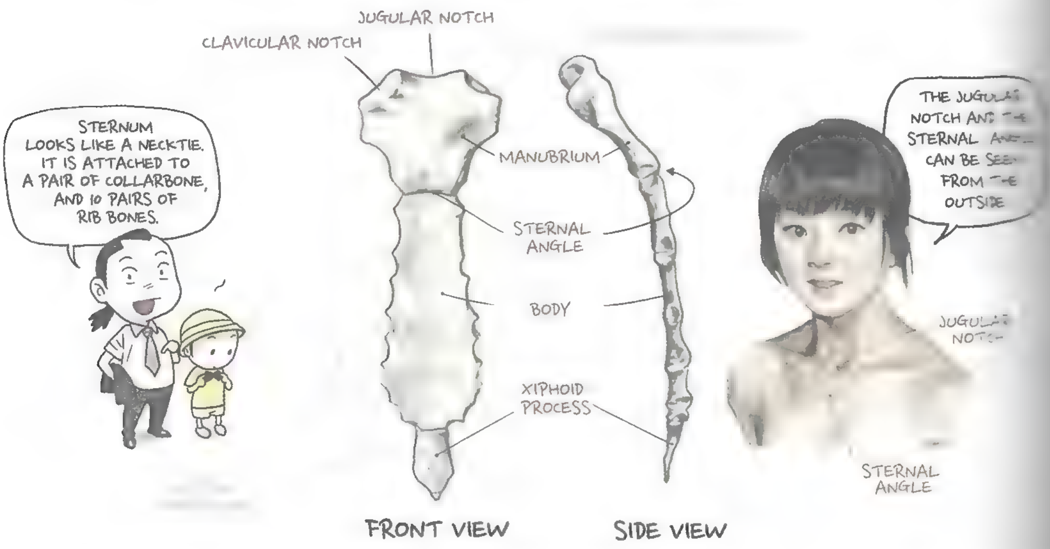
ocage, which starts from the vertebral body and the transverse process of the thoracic rae, has 12 pairs of ribs. Among them, the upper 10 pairs are structured together towards um.



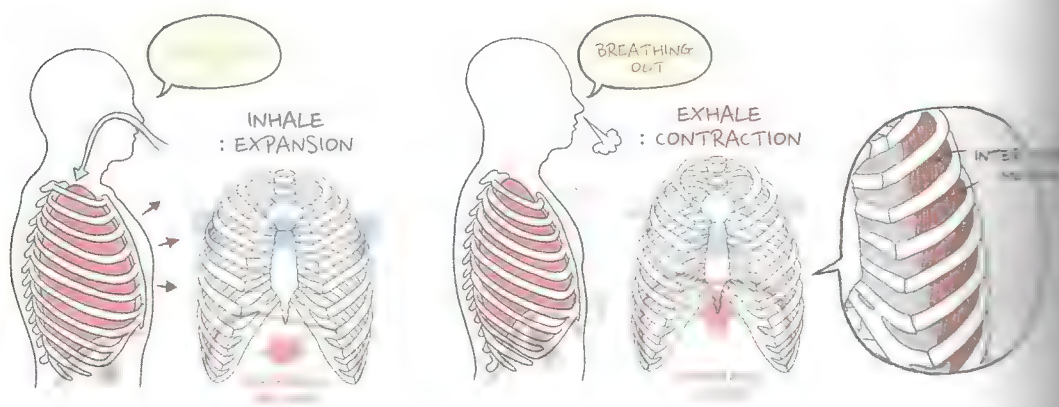
There is no direct translation for this Korean expression.
In the expression 'my chest is about to burst,' the chest actually means the heart and the lungs.
In Korean, the sternum translates to the 'bone protecting the heart and the lungs.

The sternum (breastbone) takes on the role of being the final stop for the ribs and also protec the heart and the lungs, which are located in the center of the chest. It is divided into three p Firstly, the costal cartilage of rib 1 and the 'collarbone' (clavicle) are attached to the manub of sternum (episternum). Then the costal cartilage of rib 2 is attached to both the manubri the body, and lastly, the costal cartilage of ribs three to ten are attached to the body of ster (mesosternum).

The 'xiphoid process' doesn't necessarily have a particular role, but it is often seen as one o landmarks on the exterior so it will be worthwhile to take a look.

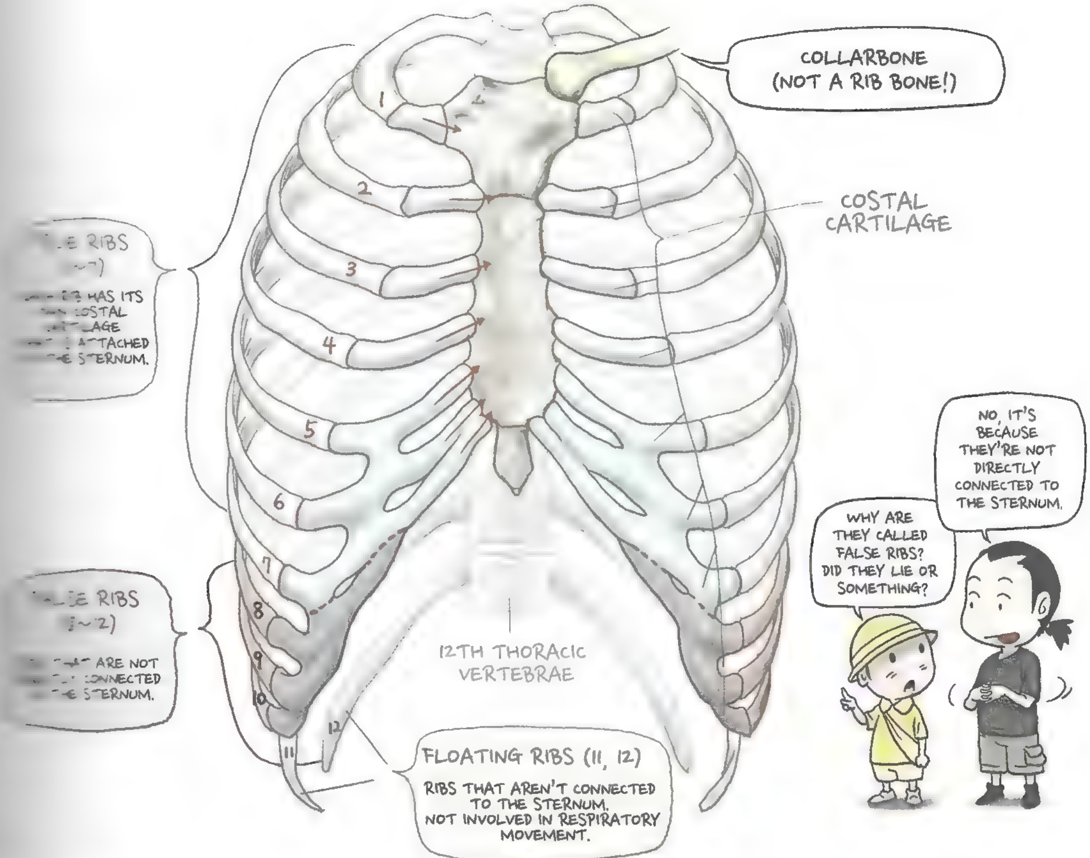


One thing to keep in mind is that the costal cartilage is connected in between the sternum the rib bones. The 'costal cartilage' protects the thoracic cage from external shock, but m importantly, it is necessary for the 'respiratory' movement, the contraction and expansion o lungs.



Inhaling and exhaling of the lungs causes expansion and contraction of the thoracic cage, and this breathing method, using the chest, is called 'thoracic respiration' (whereas using the stomach is called 'abdominal respiratio The lungs inside the thoracic cage and the 'diaphragm' rise because of the 'intercostal muscle' exhaling.

The reason the thoracic cage is able to move, even though it is made of sturdy rib bones, is thanks to the costal cartilage that is attached in between them. Remember that cartilaginous articulations move, if only a little?
The twelve ribs are divided into true ribs, false ribs, and foating ribs, depending on how the costal cartilages are attached. Please refer to the next image.



True ribs: The upper 7 pairs of ribs that have their own costal cartilage and are fully attached to the sternum. It moves the most when breathing through thoracic respiration.

False ribs: The lower 5 pairs of ribs that are not directly connected to the sternum. Although, the upper 3 pairs of false ribs have costal cartilage, like the true ribs, they are fused together into one.

Floating ribs: They are the lowest 2 pairs of the rib bones, and although they are considered as part of the false ribs, they are not at all connected to the sternum. As the name implies, it looks like it's floating in the air. Their role is to hang on to the muscles on the lower back.

Please refer to the arm bone section (p. 285) to learn more about the collarbone (clavicle).

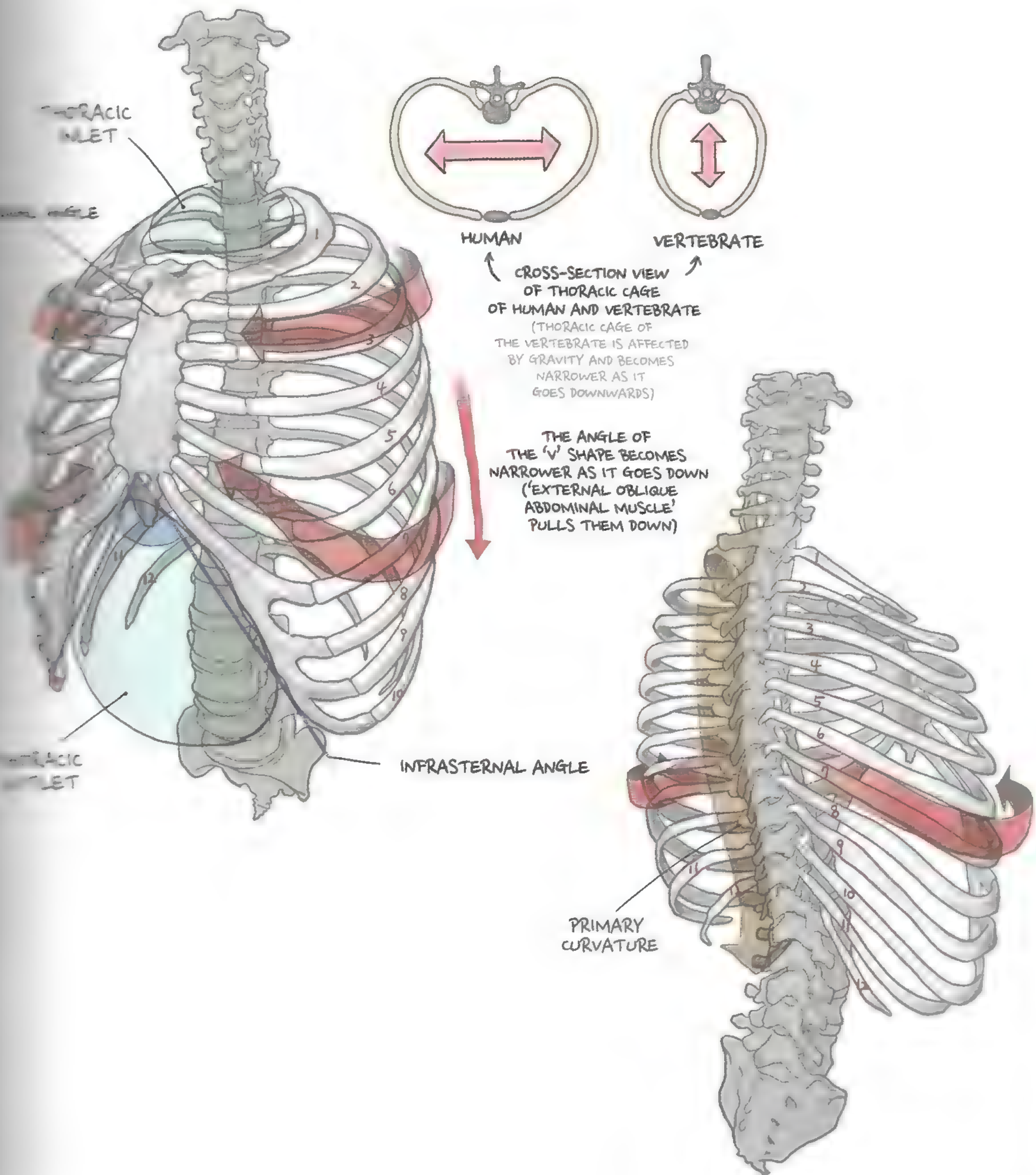
Wait! A little story about CPR

Although the ribs and the costal cartilage form a connecting structure that helps with respiration, they are also the ones to usually break when you get a fractured rib.
However, in a way, that would be better than fracturing the actual bone. That is because the actual bone fracture would take long time to heal, whereas the connecting part of the bone and the cartilage would reattach easily. You can see just how much this connected part moves, by performing 'cardiopulmonary resuscitation (CPR).'

Like the image above illustrates, cardiopulmonary resuscitation is performed using your body weight, by repeatedly pressing hard on the solar plexus (body of the sternum and the xiphoid process) and stimulating the heart inside. When you press it like the image above, the chest goes in a lot more than you've imagined. That is why it is very important to get the consent of the patient requiring aid. Although, consent is 'assumed' the patient is unconscious. It is presumed because the ribs may fracture during CPR. The person performong CPR has a risk of being prosecuted for 'assault' even though they intended to save the patient.

Of course, you will need to understand the exact condition of the patient and have a proper understanding of CPR. If you don't want to get involved in a situation like the image above. For the exact procedure of CPR, please check the 'most recent video' on the internet as the procedure may change for efficiency sake.

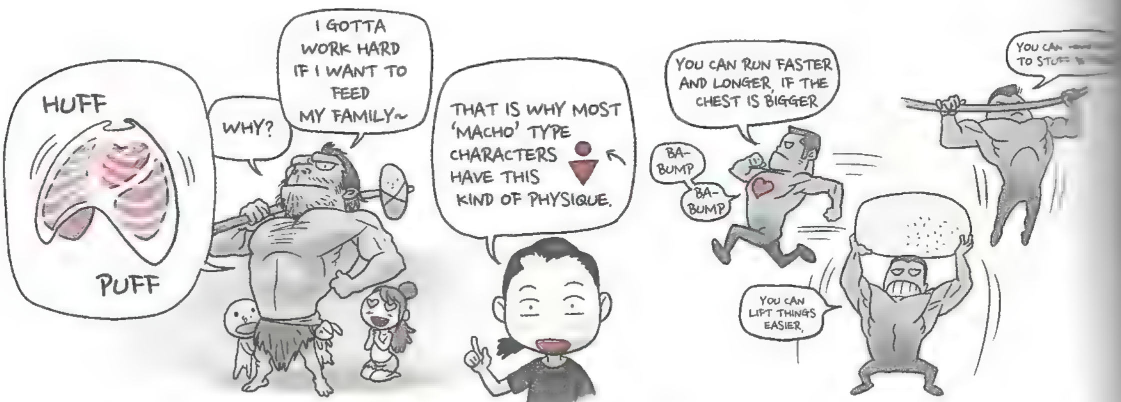
then, the entire thoracic cage is completed.
marize, let's briefly review the physical characteristics of the thoracic cage. Landmarks as the jugular notch and the sternal angle can be seen from the outside. In the case of a person, the ribs and the 'thoracic outlet' can also be seen. Please refer to p. 216 for the curvature' that forms because of the thoracic cage.



■Men, Open Your Chests Wide

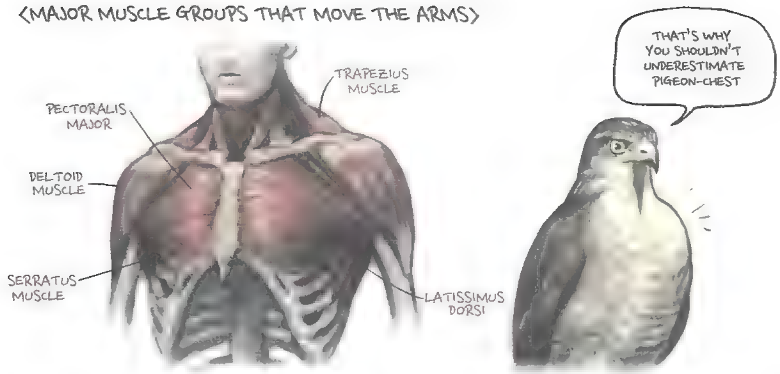
Earlier, we learned that the thoracic cage is a structure that protects the heart and the lungs a aids in the 'respiratory movement.' This is the very basic prerequisite that makes it worthy of being called the 'symbol of masculinity.'

A large thoracic cage means the heart and the lungs, the engine that moves the body, are correspondingly bigger which in turn signifies that the 'motor ability' is that much better. With better motor ability, one can overtake that much more prey. Not only is that advantageous to one's ability to survive, but also has advantage against other competition, and furthermore, the survival rate for the partner and the offspring is that much better off.



Most macho-type characters are illustrated with short legs, not because running (ability to move) is unimportant, but rather to accentuate the relatively larger thoracic cage.

The thoracic cage is attached to many muscles that move the 'arms,' which are vital to survival. Then it becomes more of a symbol of 'strength.'



Actually, the back muscles do more work in terms of moving the arms. Please refer to p. 254 for back muscles.

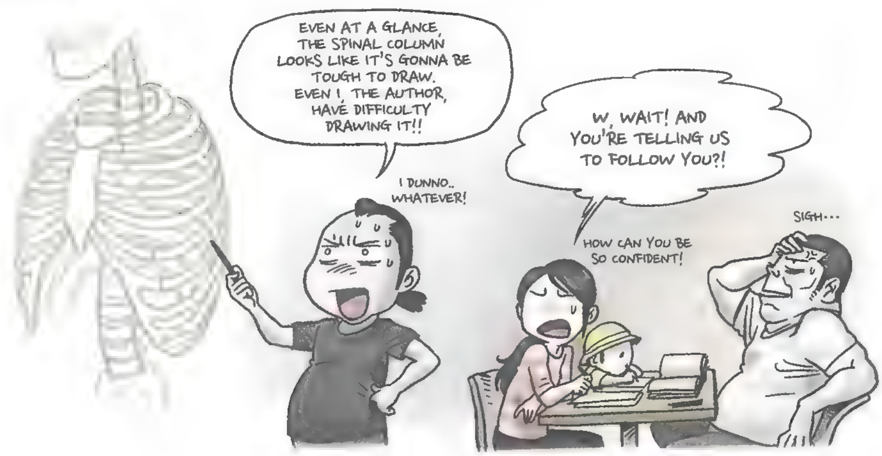
...s why men, across all ages and countries, emphasizes the thoracic cage and use many ... to make their chest look bigger. Along with it being the symbol of motor skills, the gesture ...ing up the chest, which the heart and the lung, the most important organs to preserve life ...oused in become the symbol of confidence.

...e contrary, when the thoracic cage is smaller, it becomes a symbol of 'delicacy.' Therefore, ...e natural that women, who have relatively small thoracic cages and breasts, are attracted ...en, who have big shoulders and a wide chest?

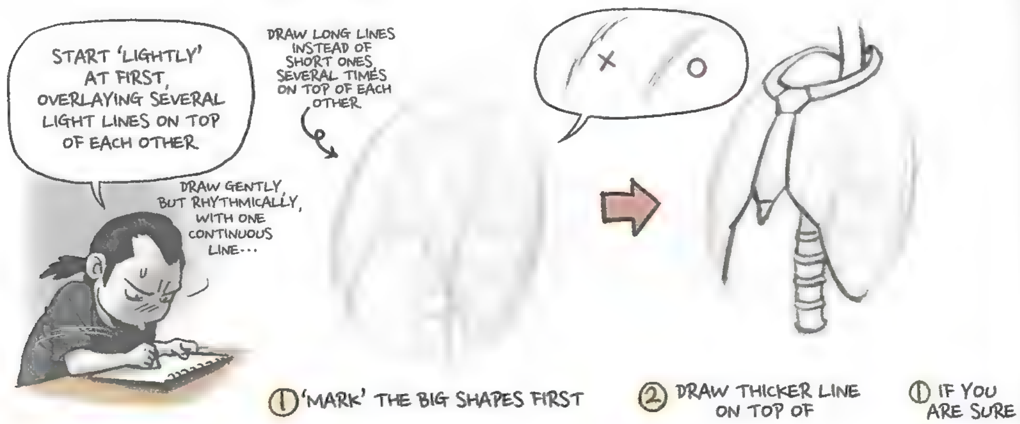
■Let's Draw the Thoracic Cage!

❶ Before you get started

This time we will be drawing the spinal column and the thoracic cage, in other words the torso as a way to review the pelvis and the chest we studied earlier. Because the spinal column and the thoracic cage have many units of bones that are connected together, you can say that this is the most complex and difficult part of the human skeleton to draw. To be frank, it's really not that easy.



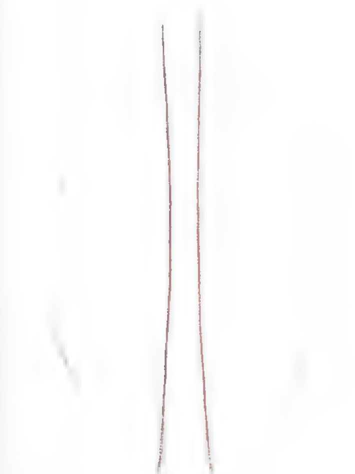
Because it is hard, the sense of accomplishment you get after completing the drawing is no different from completing any other project. Before we begin, I will teach you a simple trick to make drawing the torso a piece of cake. This trick is actually a commonly used drawing technique, but because it's not as easy as it looks, it will be a good idea to practice whenever you can.



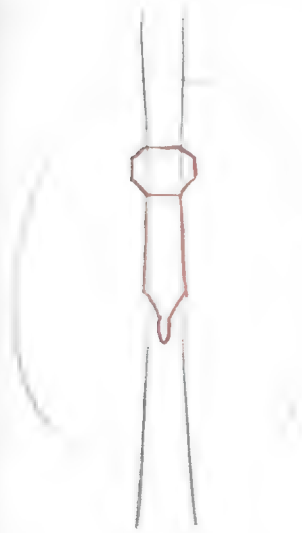
Now, are you ready? Let's embrace the thoracic cage and go to the next page.

Drawing the front view

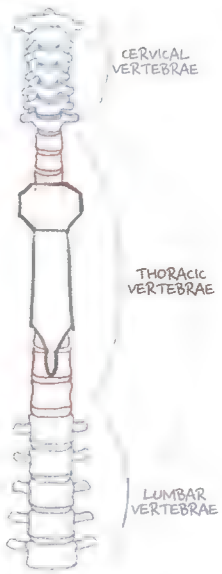
This is the process of drawing the front view of the thoracic cage. Have patience, and let's take one step at a time.



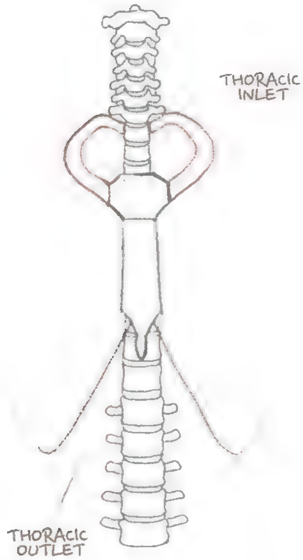
01. First, draw an egg-like shape. This egg-like shape becomes the frame of the thoracic cage, and the frame of the spinal column is set once you draw a stick with the top and bottom slightly tapered out. The trick is to draw them lightly because this is not the completed form.



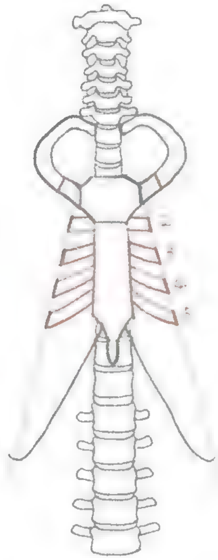
02. Draw a necktie, with an octagon-shaped knot on top using, a thick line. This, of course, is the 'sternum.' The knot would be the manubrium of sternum (episternum), and the ribbon would be the body of sternum (mesosternum).



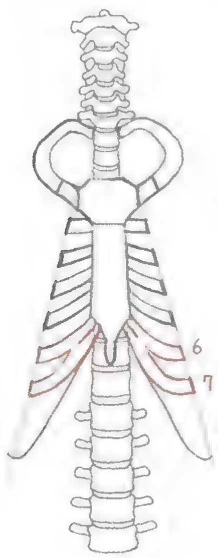
03. Let's illustrate the spinal column on the back. There are seven cervical vertebrae and five lumbar vertebrae. The thoracic vertebrae which lie in the middle are twelve in number but most of them are covered by the sternum So, you only need to draw a part of them.



04. Once you draw the rib that connects from the T1 vertebra and the sternum in a shape of a heart. The thoracic inlet is complete. And on the bottom side, if you mark where the 'costal arch' is with a shape of an 'A,' you are ready for the next step.

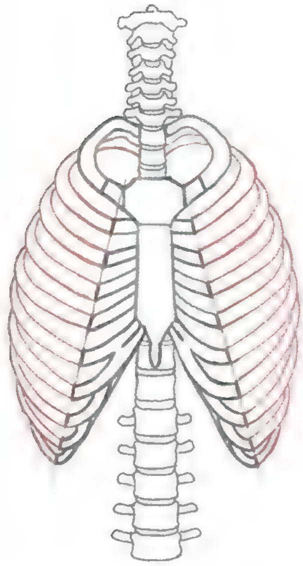


05. Now, start drawing the breastbone. First, lightly marking the base line, starting from the sternum down to the angle where costal arch ends. Then start drawing the costal cartilage from no. 1 and down.

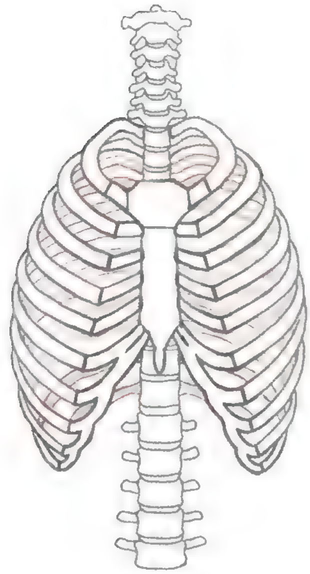


06. You can draw the costal cartilage individually from no. 1 to no. 5, but they are joined with each other from no. 6 and no. 7. They show the difference in appearance. Up to these ribs the cartilages are connected to the true ribs.

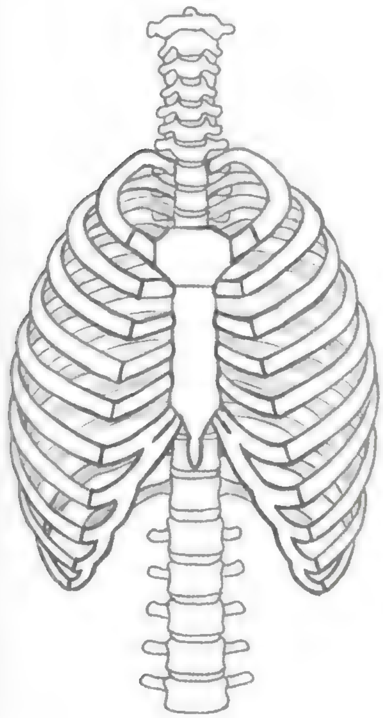
07. From cartilage no. 8 and onwards, they look like they are branching out like a tree and connecting to the cartilage above. From this point on is where the false ribs are connected, but rib 11 and rib 12 are not connected, and are called floating ribs. They are not visible from this point of view.



08. Draw the ten ribs like they are coming around from the back to the front, and connected to each of the cartilages. As you go down, you will notice that the way they are connected to the cartilages looks more like a V-shape.



09. Let's draw the rib bones on the back side. This may be a bit confusing, but if you draw crease lines here and there on the ribs on the back side, it'll be easier to separate them.

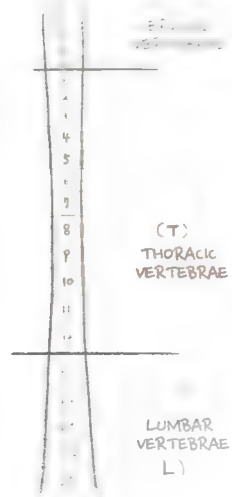


10. You are done once you get rid of the messy lines and clean up the outline.

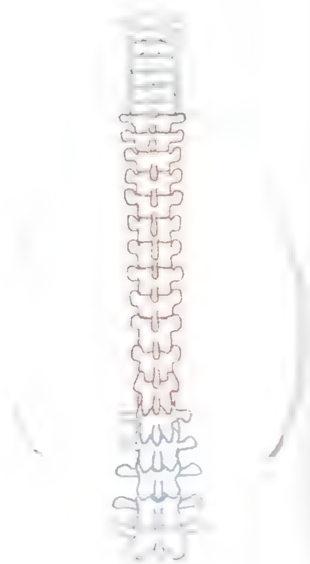
❸ Drawing the back of the thoracic cage

01. In the same way as when drawing the front view, let's mark the egg-shaped thoracic cage and the spinal column in the middle. Don't forget to draw them lightly.

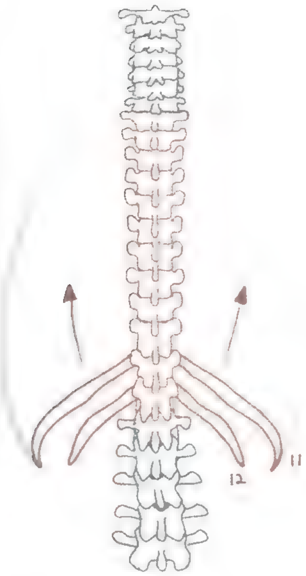
02. Divide the spinal column into three parts: cervi vertebrae, thoracic vertebrae and lumbar ve Please keep note that the starting point of the lumbar vertebrae is inside the thoracic cage.



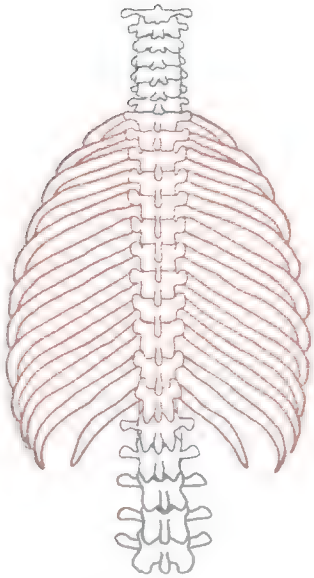
03. Like the image above, mark lightly and divide each part of the spinal column. The spinal column then becomes thicker as you go down.



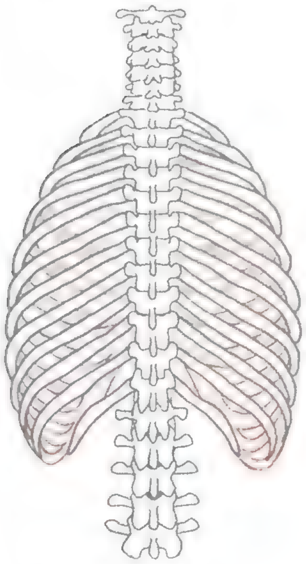
04. Let's draw each vertebra using the marks we as a basis. It is difficult and a hassle, but you to put an effort on this part for the next step



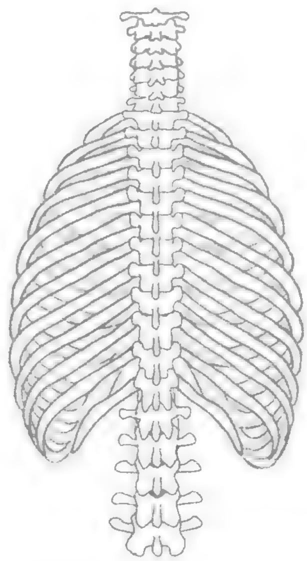
Let's draw rib 11 and rib 12 as you pay attention to the downward-pointing angle. These guys are called 'floating ribs.'



06. The rest of the ribs have a similar angle to the 'floating ribs.' It is easier to draw from the bottom up.



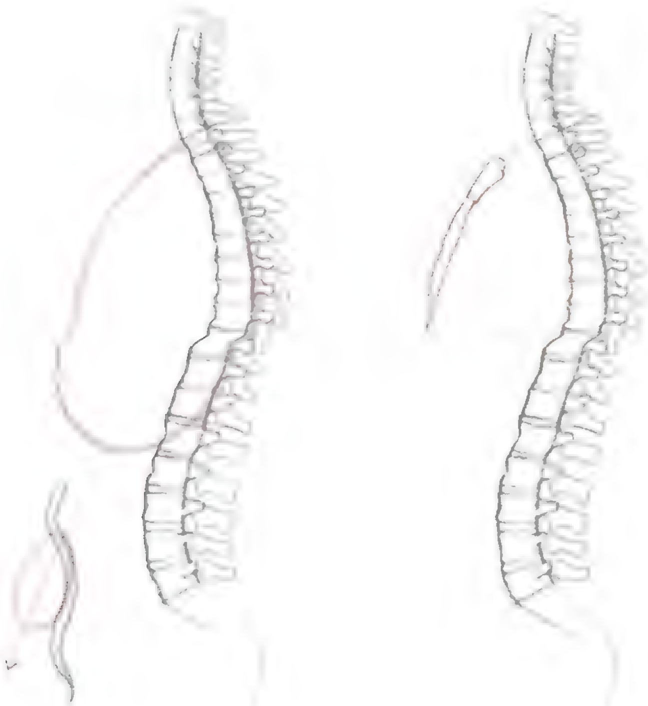
Ribs, except for 'floating ribs,' point toward the sternum in the front. Let's draw the ribs at the front which would be visible between the ribs at the back part in the same way we did when drawing the front view of the torso.



08. You are done once you clean up the lines.

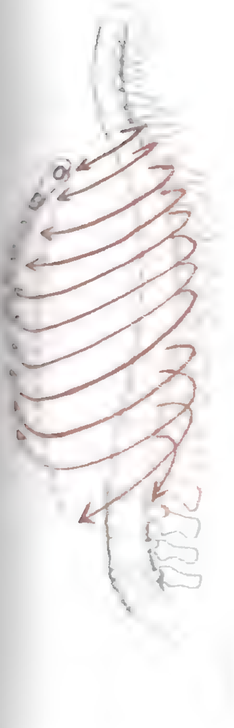
❹ Drawing the side

01. You can see the spinal column's true form when you look at it from the side. Draw in the order of segme[illegible] of 24 vertebrae → spinous process → transverse process after first marking the overall shape of the spinal column.



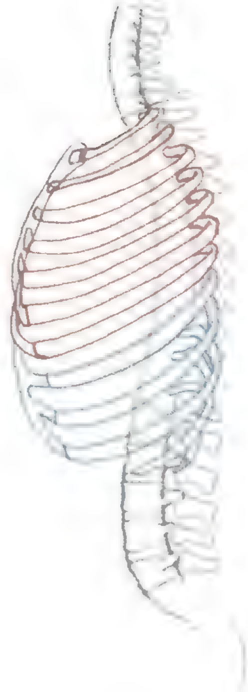
02. The reason the spinal column has a curvatu[illegible] in the middle is because it needs to *hold on to the* [illegible] cage.

Lightly mark the *thoracic cage in a* shape of a slanted water balloon and draw the sternum in the front, like the image.

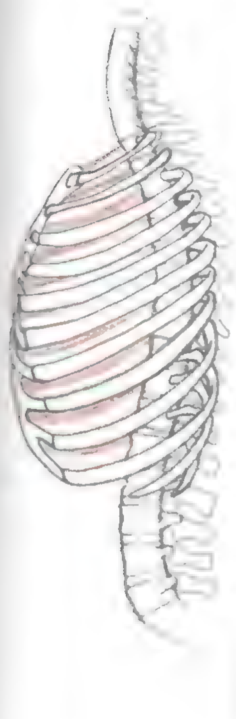


03. Draw the guidelines for the ribs that are pointing towards the sternum, starting from rib 1.

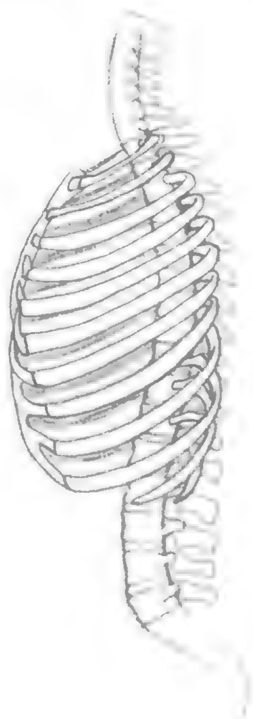
The angle of the ribs pointing towards the sternum becomes steeper as you go down.



04. Connect the rib and the cartilage one at a time, using the same guidelines from the previous step.



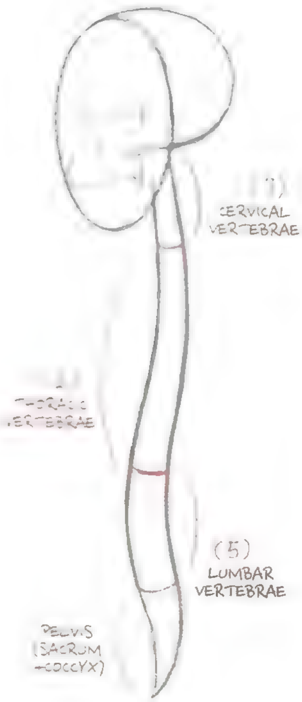
05. Let's illustrate the ribs on the other side. To be honest, you don't have to be accurate in this step.

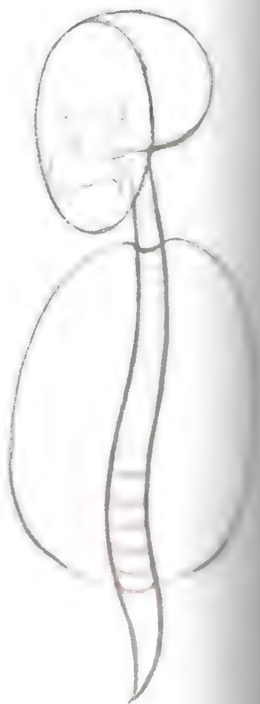


06. You are done.

❺ Drawing the three-dimensional thoracic cage

Although we have been drawing the thoracic cage, the previous processes were more like 'no[...] taking' with a diagram to understand the average shape of the bones and patterns. What I m[...] is that no matter how realistically you draw them, it will not be enough to understand the three-dimensional shape of the real torso. Therefore, we will be gauging the three-dimensional sha[...] of the spinal column and thoracic cage by drawing quarter-view diagrams.

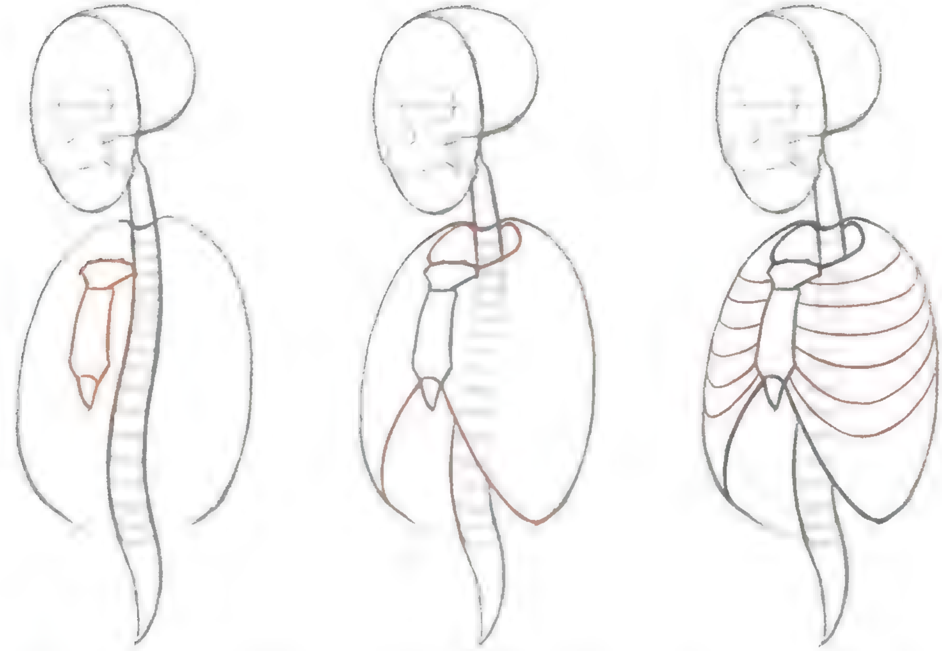




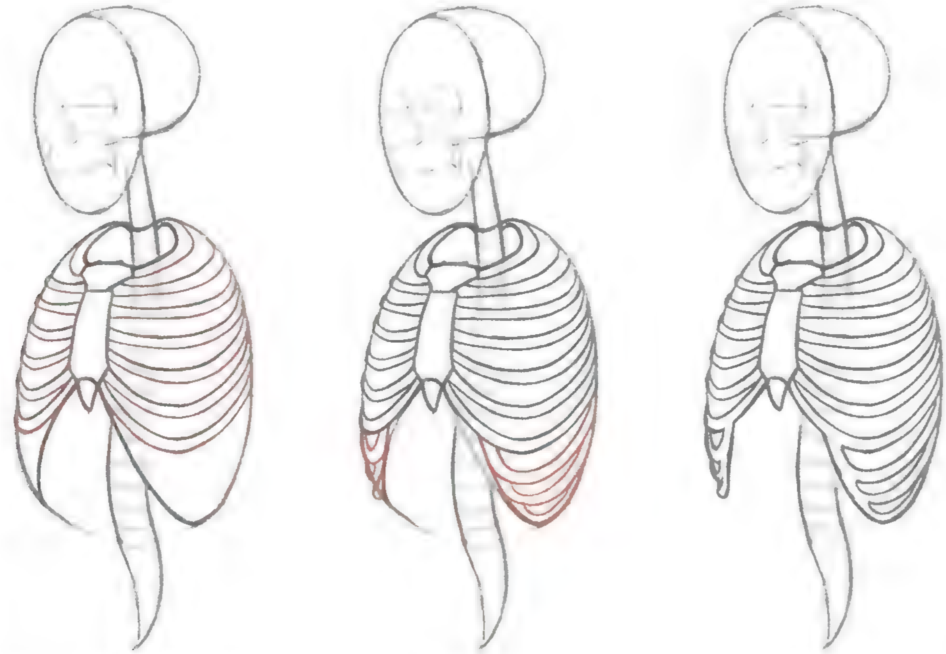
01. Let's mark the spinal column on the skull we drew in the previous chapter. It looks like a tadpole.

02. As always, let's separate the spinal column into cervical, thoracic and lumbar vertebra. We'll cover more in depth the sacrum, which the pelvis is attached to.

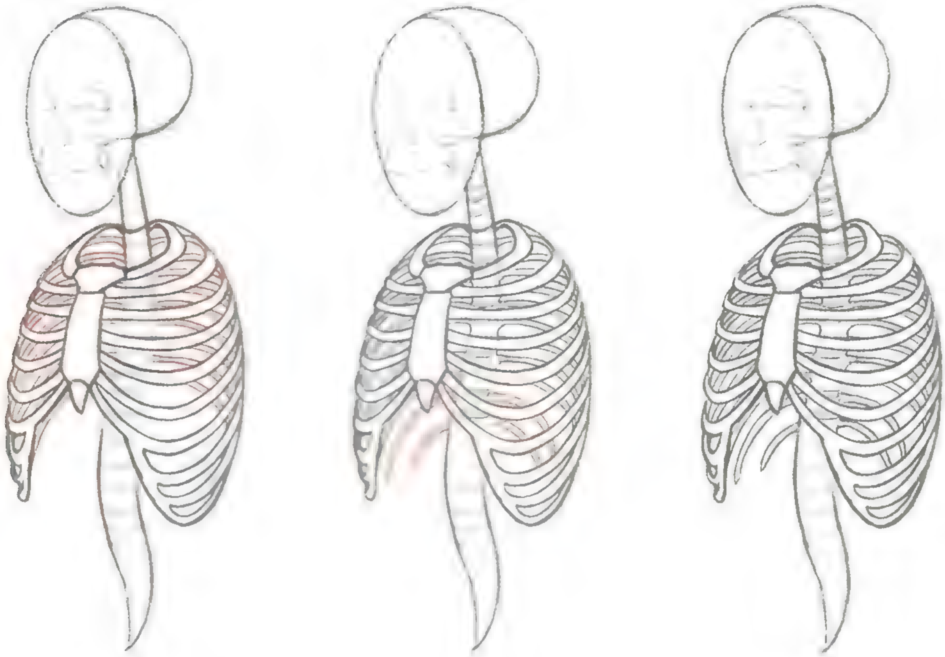
03. Separate each vertebra [...] the guidelines and dra[...] framework of the tho[...] cage over the spinal column.



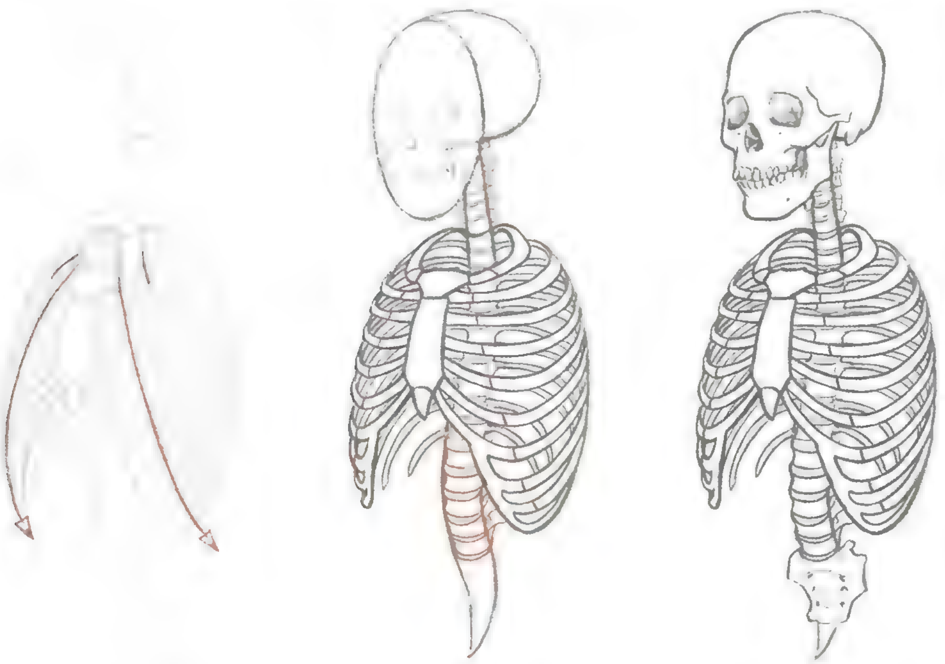
04. Illustrate in the order of the sternum → the thoracic inlet, costal arch → mark the guidelines for ribs 1 to 7 (true ribs). The rest of the process is the same as drawing the front view of the thoracic cage.



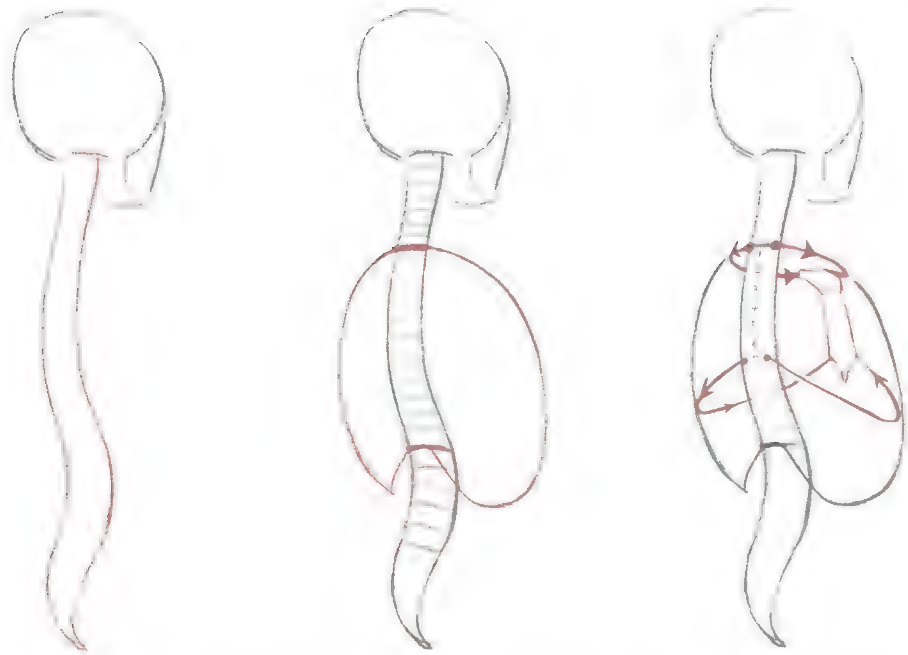
05. This is the process of illustrating the true ribs → false ribs (rib 8 to rib 10) and erasing the rough lines used as guidelines.



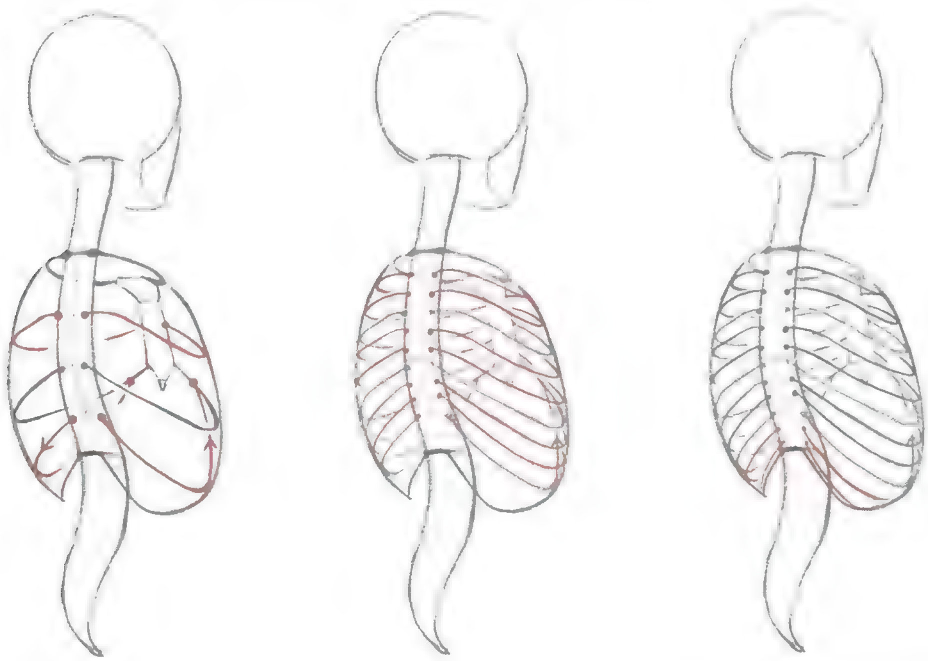
06. Illustrate the ribs on the back → illustrate the floating ribs (ribs 11 and 12) → erase the overlapping part of the spinal column on the ribs.



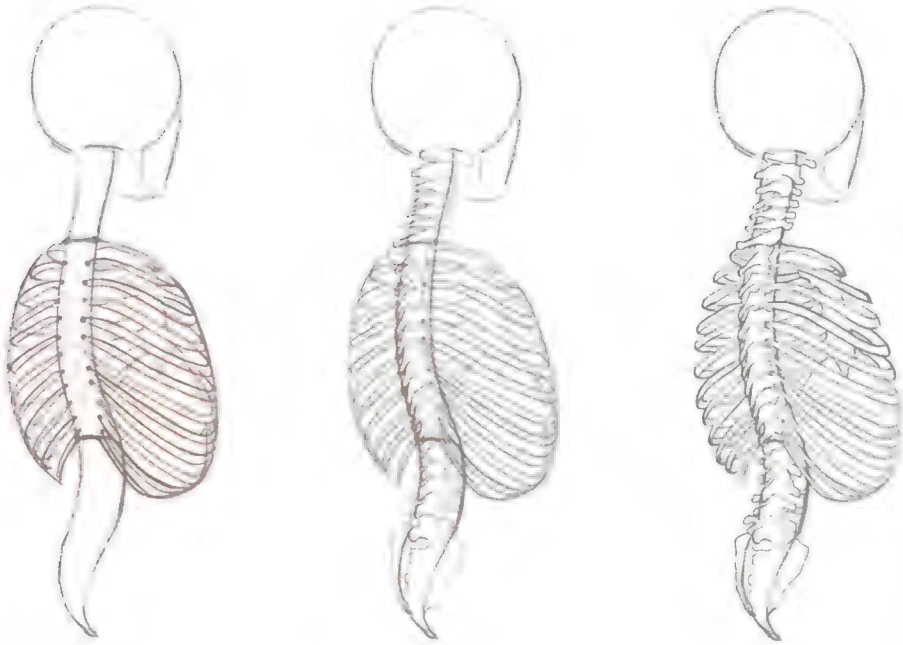
07. And lastly, mark the boundary line between the costal cartilage and the ribs → illustrate the transverse process of the cervical vertebrae and intervertebral cartilage (disk) of the lumbar vertebrae → draw the skull and the sacrum.



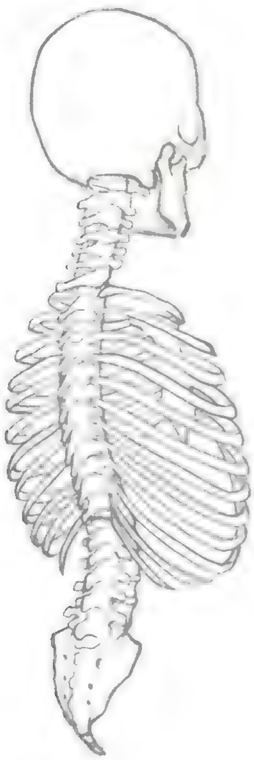
08. Let's draw the back view, too, while we're at it. The back view of the thoracic cage is much more difficult compared to the front view, so let's put the even more complicated vertebrae aside for now, and let's first mark rib 1 and rib 7 that connects to the sternum in the front as guidelines.



09. Instead of drawing them in order, let's draw ribs one to ten by dividing the bigger shapes into halves and filling in between, and then add the floating ribs on the bottom, and you're ready to go.



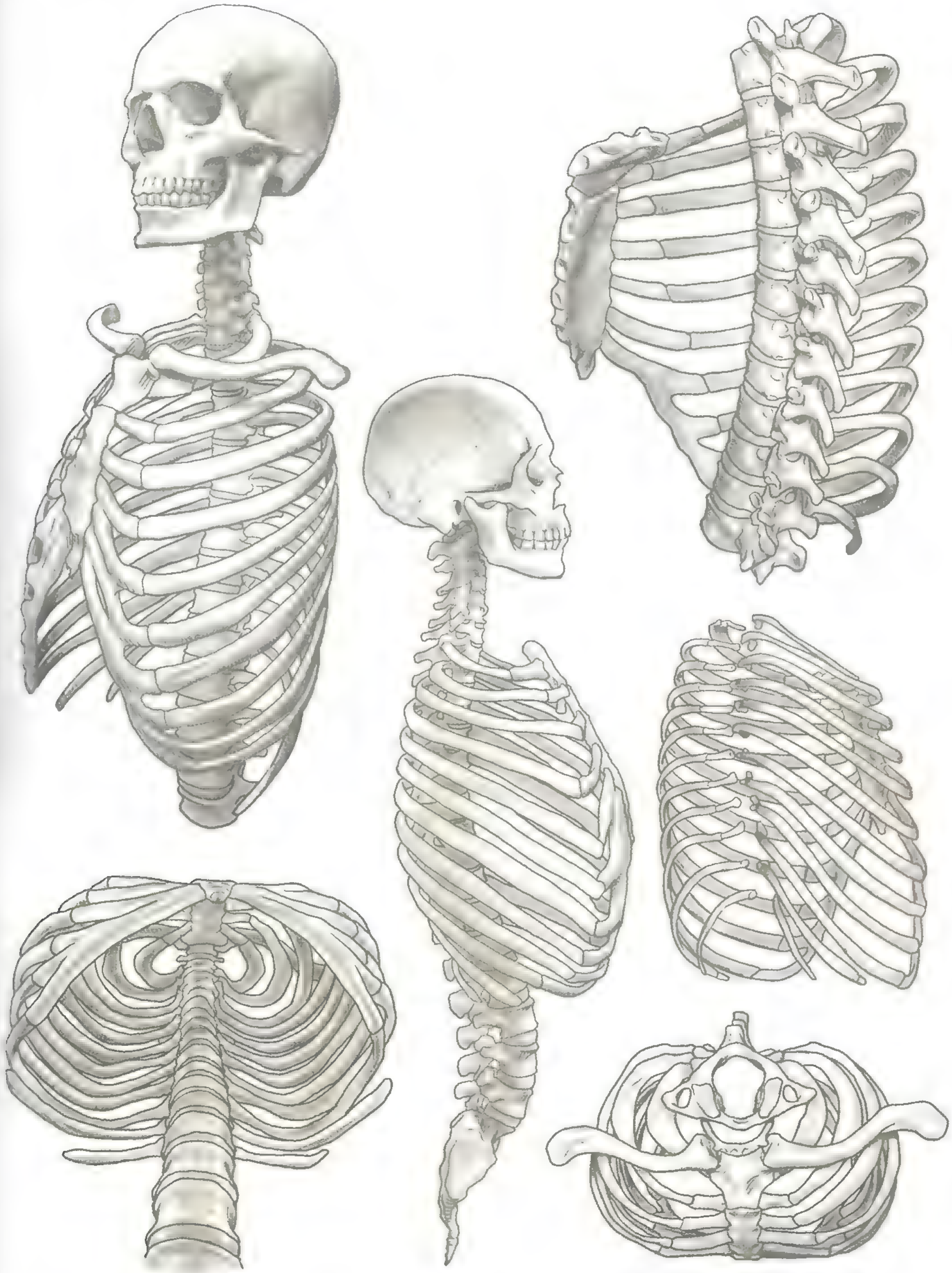
10. Next, draw individual ribs one by one, using the guidelines you just added. Once you're done with the ribs, let's draw the spinous and the transverse process of the vertebrae. The starting point of the ribs should be on top of it.



11. Erase the messy guidelines and finish the image by drawing the skull and the sacrum.

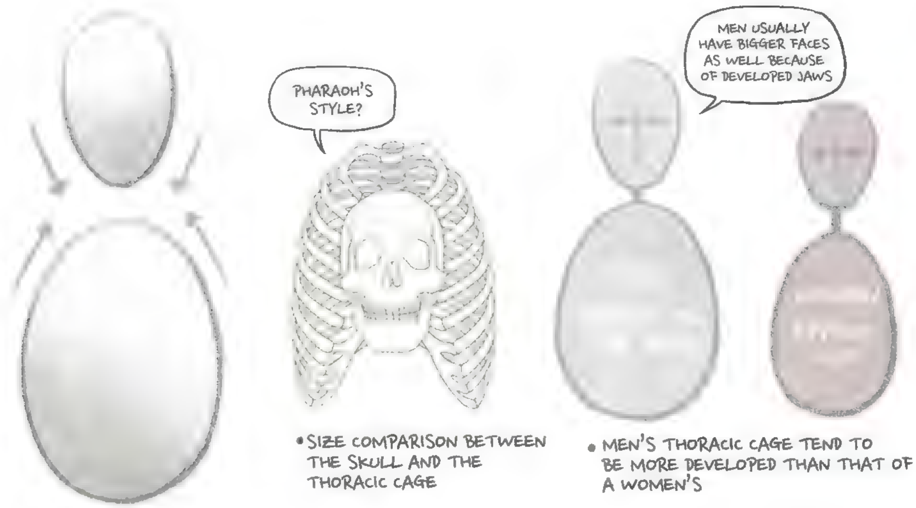
■Various Shapes of the Thoracic Cage

Below, you'll see the thoracic cage from various angles. Please use them as a reference when drawing the thoracic cage.

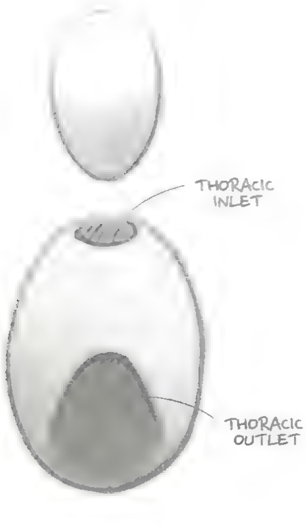


■Simplification of the Thoracic Cage

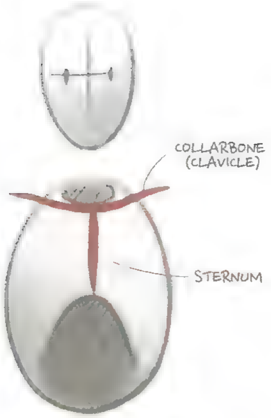
We've been drawing various shapes of the thoracic cage up till now, and as a last step we will simplify them as a way to wrap things up. When looking at the big picture of drawing, ribs are only a small part so we will exclude them and just draw the thoracic cage from the front view.



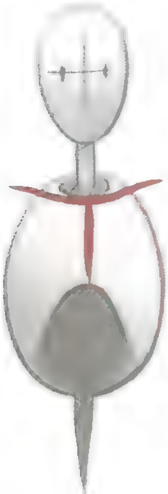
01. The basic shape of the skull is an egg in a bottom-side-up orientation, meaning 'reversed egg' shape, and the thoracic cage is the 'up-right egg' shape. The ratio of skull to thoracic cage is similar for both genders. Ho men are usually bigger because motor skills, which were traditionally important to men require bigger heart and the lungs and the ability to support the bigger muscles on the upper body.



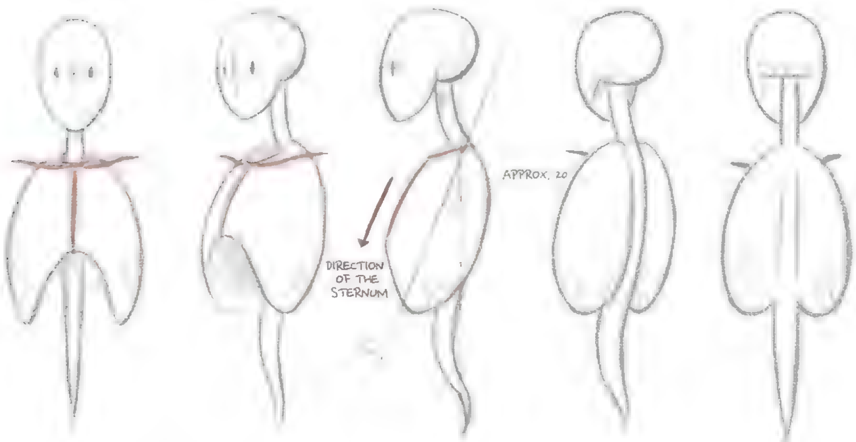
02. Mark the thoracic inlet and the thoracic outlet on the egg that is the thoracic cage (as if you are sawing off pieces when practicing 'egg craft'). The thoracic outle tends to protrude especially more on women or skinn people.



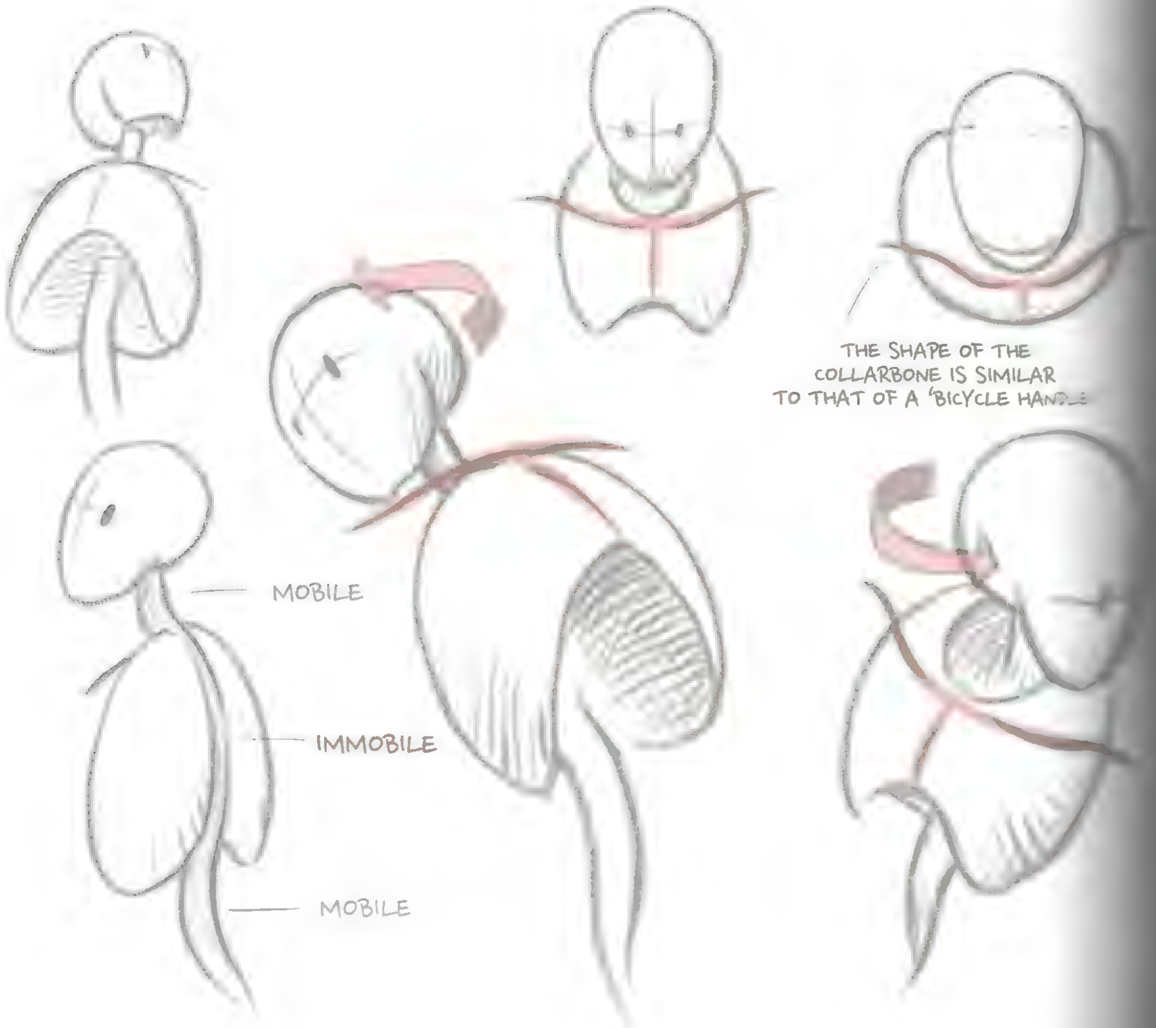
03. Draw the T-shaped guidelines on the thoracic cage, along with the cross line on the head. The horizontal line in the T-shaped guideline is the collarbone (refer to p. 285), and the vertical line is the sternum, and this guideline becomes an important landmark when drawing the upper body so it's a good idea to always draw them in.



04. Once you're done illustrating the spinal column on the back, you're done. Piece of cake, right? Although we've compared it to and 'egg,' it's hard to simply think of the thoracic cage as an egg when looking at it from different angles. Please refer to the images below.



The bottom of the thoracic cage looks like it's sticking out a bit, and as a result the back is slightly curved (primary curvature - please refer to p. 216). Please pay attention to the spinal column digging into the back of the thoracic cage as well.



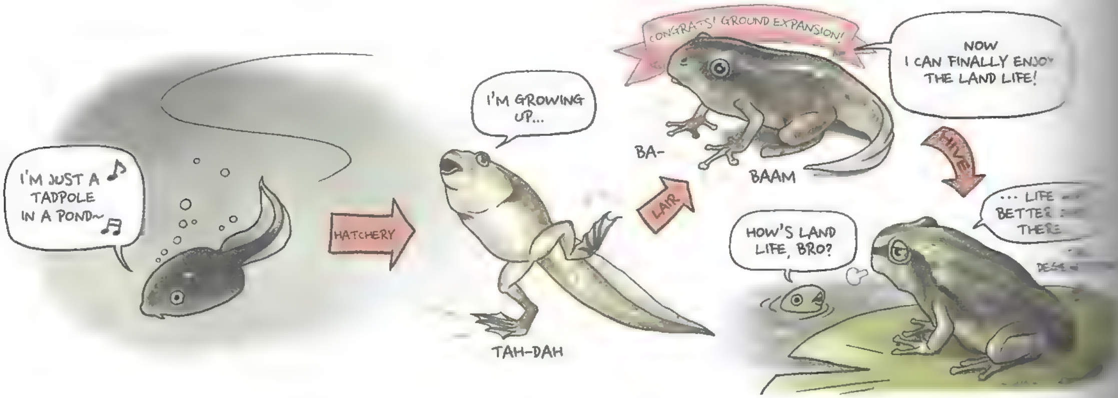
Besides the various physiological reasons mentioned earlier, you must to put a lot of effort in *when drawing the thoracic cage because it's the most important and practical structure that* constitutes the 'body,' which is the root of the arms and the legs.

Nude figure study demo / Painter 9.0 / 2009
The word, 'body' also means 'core,' in general terms.
Its importance is obvious when drawing human anatomy

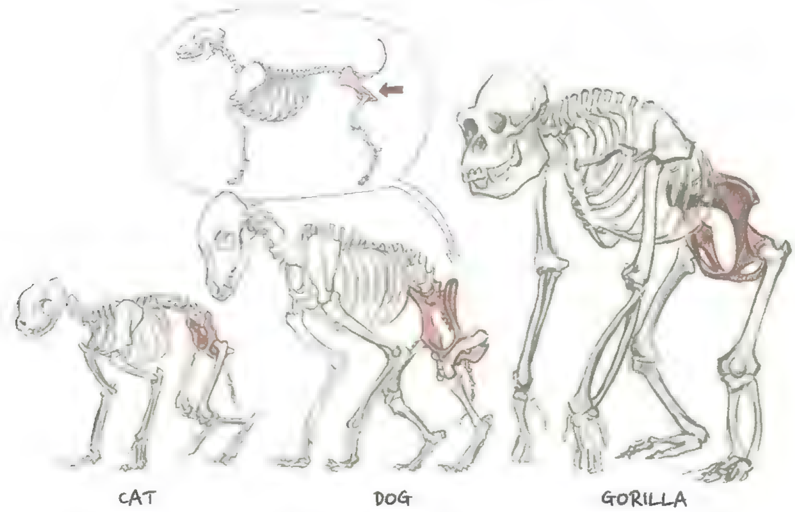
Pelvis, the Center of the Body

■Everybody Dance with Your Pelvis

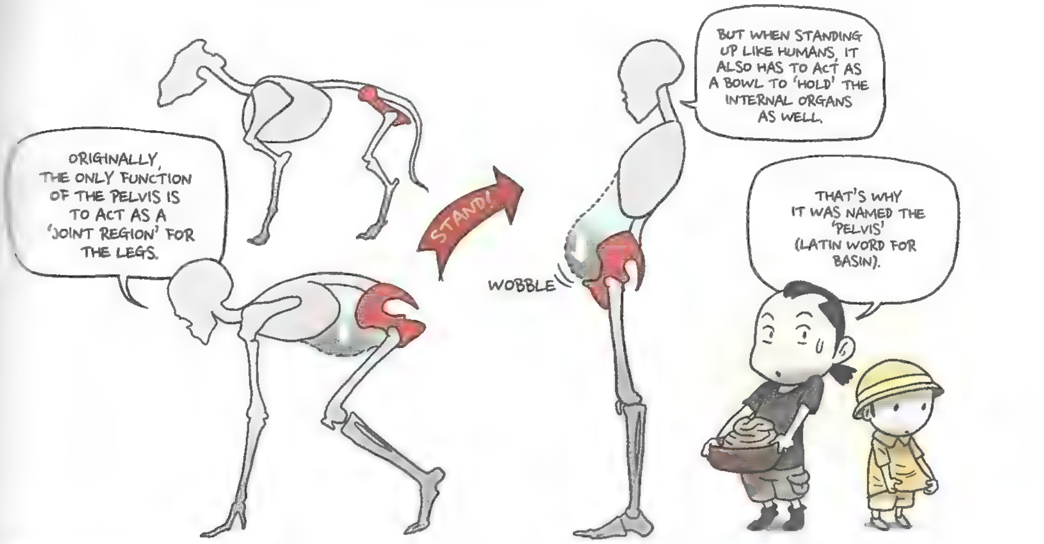
Do you remember how I told you earlier that 'moving' is vital to the survival of any lifeform? Th 'spinal column' and the 'thoracic cage' are parts of the body meant for said movement. In th case of fish or tadpoles, they can move around towards the direction they want with just the column. However, you need a more specific propulsion system on land where you have ext restrictions such as gravity and friction. This is the reason why 'legs' exist.



This may be obvious, but with legs you need a specific structure that will connect them w body. Therefore, almost all vertebrates that live on land, where gravity is in effect, has a ske structure that legs are attached to.



This skeletal structure is called the pelvis and although appearances may differ slightly for different animals, its basic function as the 'joint region' where the legs are attached to is the same.
But the human pelvis is a bit special. That's because humans 'stand upright.' The human pelvis has a unique shape compared to other vertebrates because it not only serves as a joint region of the legs, but also has to function as a bowl to hold internal organs such as the colon, bladder, uterus, etc. that are related to excretion or giving birth.



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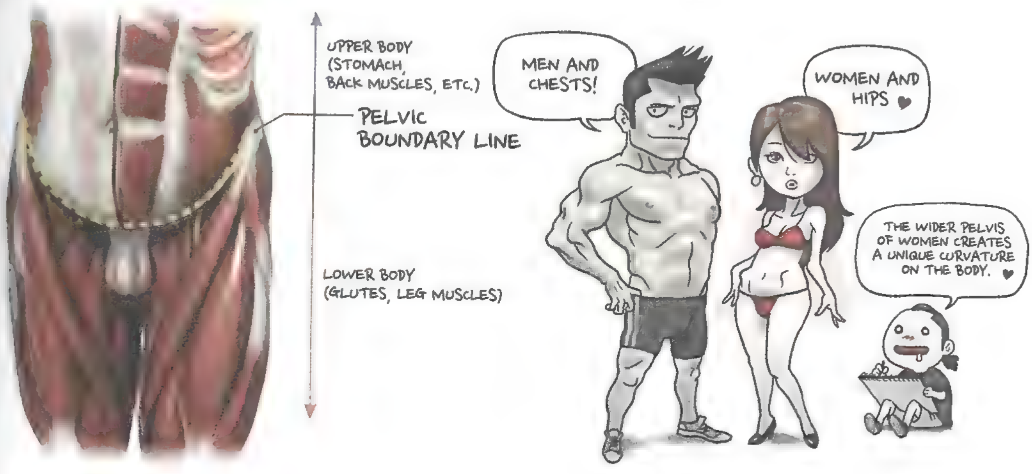
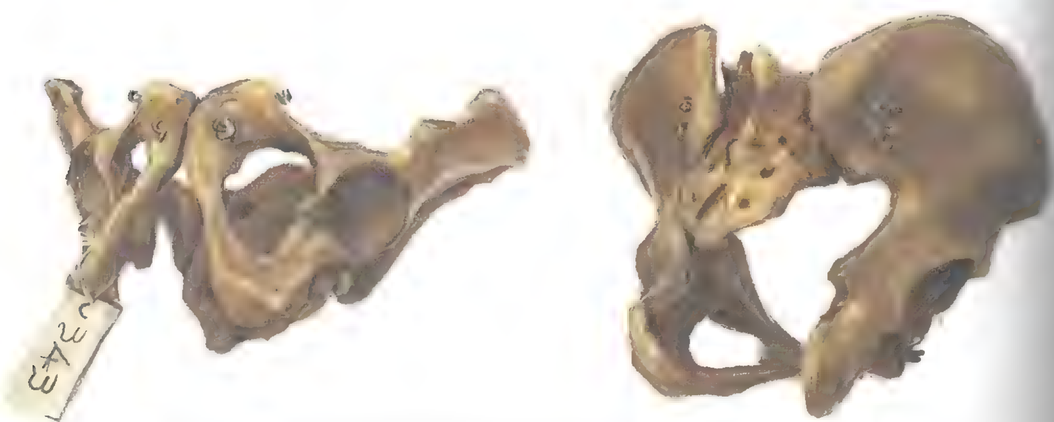


So even though it is hidden inside the body, the pelvis is an important part that should not be neglected by artists because it plays a big role both inside and outside the body. The problem is that it's not easy to understand what it looks like! *cry face* I can't describe my confusion when I first saw the pelvis in person, when all the time I was studying anatomy, I only thought of it as a 'butterfly shape.' Forget about understanding its functions, it took me years to just fully understand its mysterious shape.

Not only does it have many different functions, but it is also shaped funny and looks different depending on sex, age and even the angle you are looking from. Just looking at the images below, for instance, how many of us here could think that these two structures are the same?


'Crown and the helmet' - illustrating the model of an actual pelvis / painter 9 / 2010

Therefore, to understand this ambiguously shaped pelvis in a dimensional way, we must think about the appearances it will have according to the 'functions.'
Now, shall we get started?

Basic Form of the Pelvis

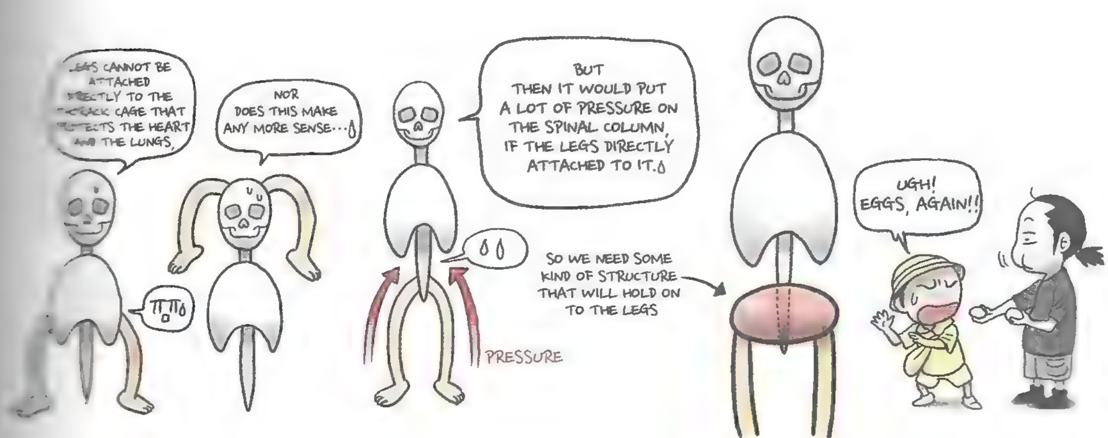
assume that we don't know at all what the pelvis looks like, and we'll slowly shape it out like modeling it with clay. Understanding the simple principle may be the key to solving such cated problems.

it is necessary to recall the functions of the pelvis. If the first function of the pelvis is to act joint region for the legs to attach to, then what would be the best way to attach the legs to ody which consists of the spinal column and the thoracic cage?

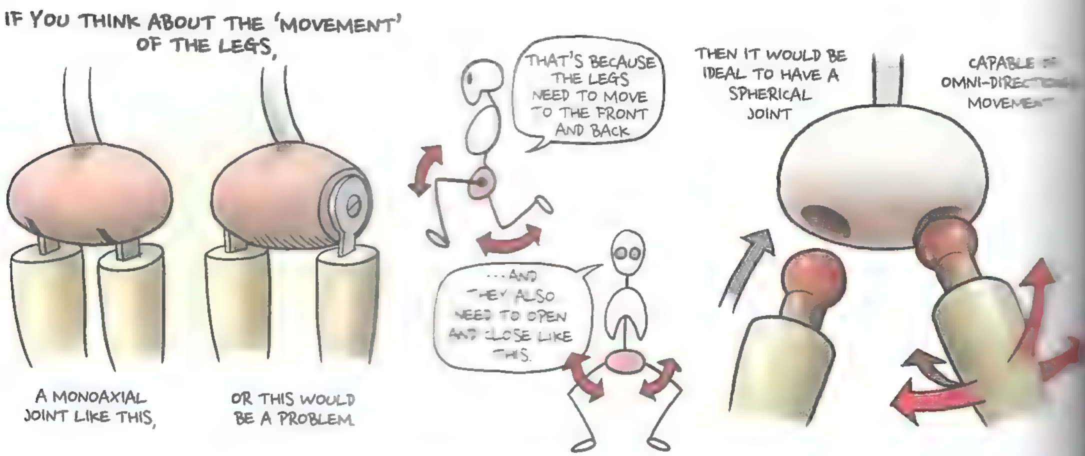
gs have to withstand gravity and also have a lot of mobility, meaning the particular structure ey are attached to would take a lot of shocks, so it would be problematic to directly attach gs to important organs that preserve life, such as the head or the chest. The legs could he heart or the intestines by any possibility.

ore it is ideal to be attached to the 'spinal column,' the most basic form of transportation. will require a special structure just to hold on to the legs because it cannot withstand the and the pressure all on its own, even though it may be the pillar of the body.

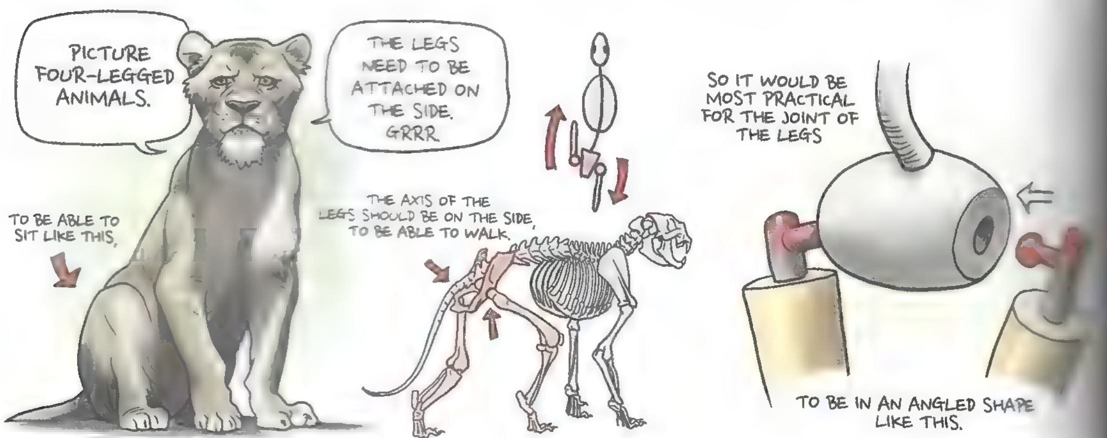
ecause we don't know what this structure actually looks like yet, we'll temporarily substitute the shape of an 'egg.'



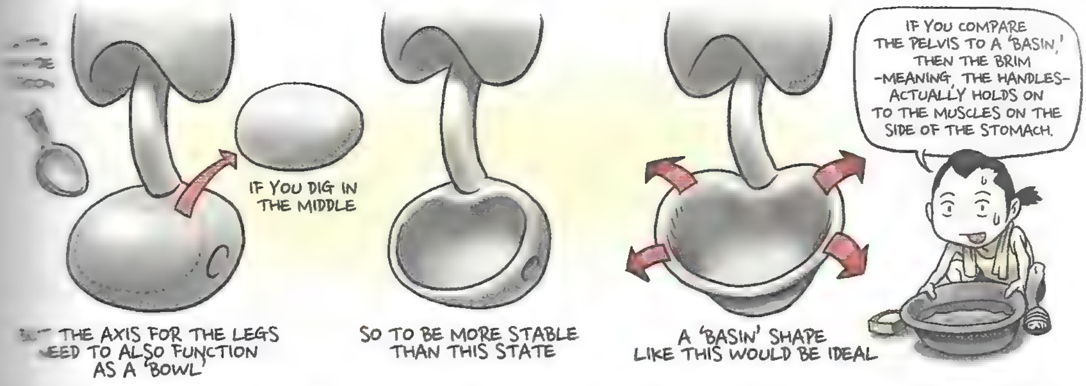
Then, what is the effective way for the legs to attach to this egg-shaped structure? To shape a pelvis that functions as a 'joint region' to attach the legs, we first need to think a the various 'movements' of the legs. In other words, this structure called the pelvis has to be an ideal shape for the legs to move freely.



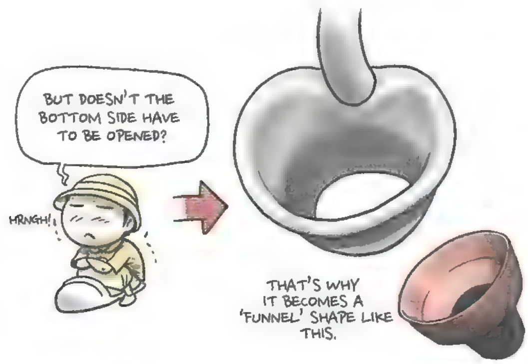
Even with a spherical joint that enables various movements, the joint region of the legs ca be attached at the bottom in a straight line since it would be hard for vertebrates to move to mention that humans don't walk on two legs right from the moment they are born) and would be no space for excretion or giving birth. Therefore instead of going straight down joints would have to be attached to the pelvis at an angle and the acetabulum, where the the joint are connected, would naturally be located on the sides rather than underneath.



The inside of the pelvis needs to be caved in like the image on the right, because the pel function as a 'bowl' for the internal organs, other than its function as a joint region for the le

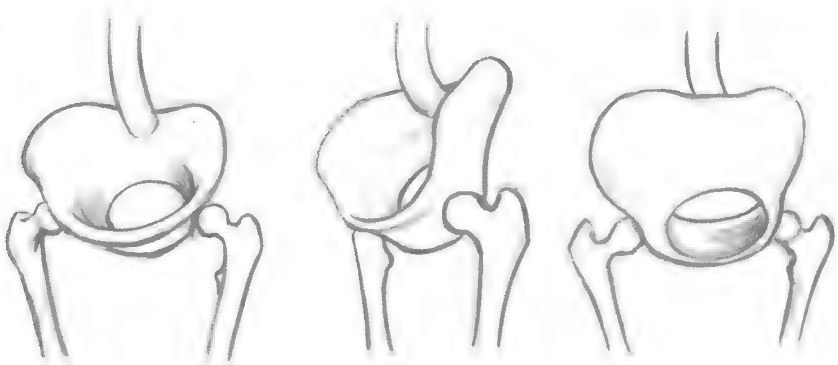


onally, although the pelvis is a 'bowl' that holds the internal organs it would be problematic e bottom was closed when you think about excreting and giving birth. Of course, the bottom e pelvis is opened, but you needn't to worry about the internal organs falling down because blocked by a structure called the 'pelvic diaphragm,' made of sphincter muscle that can e and open.



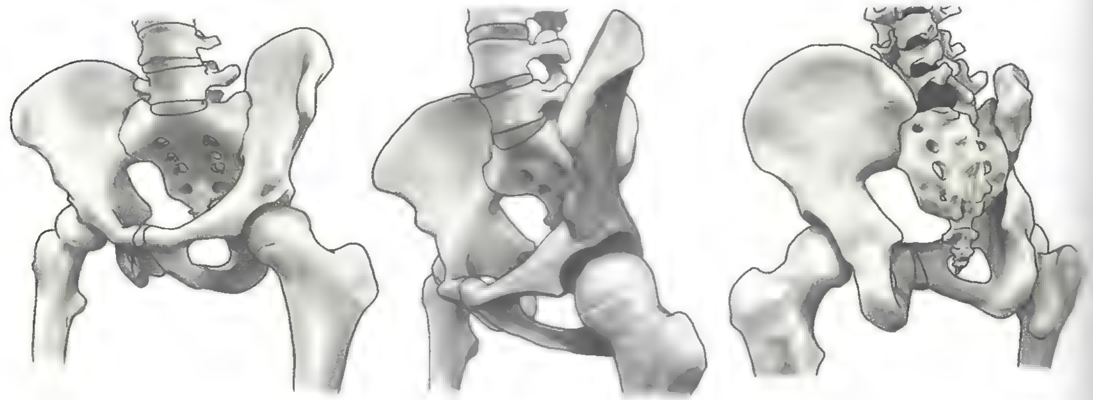
Although I used the funnel as an example, it is more the case of the male pelvis, while the female pelvis has the shape of a wide bowl. Please refer to p. 189.

efore, the pelvis generally takes the shape like below. You can think of it as the basic form of e pelvis. It's not that hard so far, right? Let's move on to the next step as you let the information in.

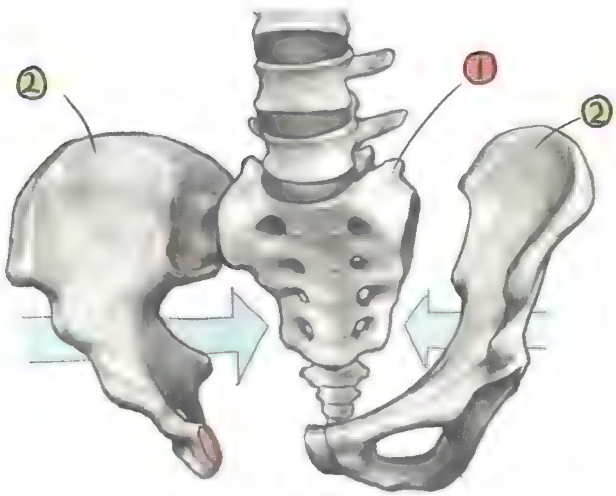


■Shape of the Pelvis

Understanding the pelvis with the information learned so far would be fine, but I'm compelled to add more detailed structure because aside from its basic role, the pelvis also serves as the 'frame' that secures the many different muscles of the stomach, back, legs, etc.
Therefore, it is necessary to understand the actual shape of the pelvis to understand the muscles around it. The images below show the simplified version of the pelvis.



Oh, it's natural for you to grow confused again when you look at the actual pelvis… after thinking you understood the shape of it to a certain degree. Why is it so complicated looking with so many parts that stick out or cave in? Theory and the reality are so different.
But don't feel too troubled. No matter how complicated it looks, it is only two separate bones fused into one.



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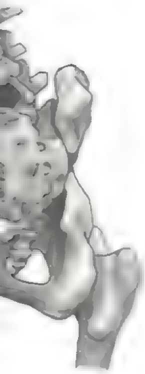


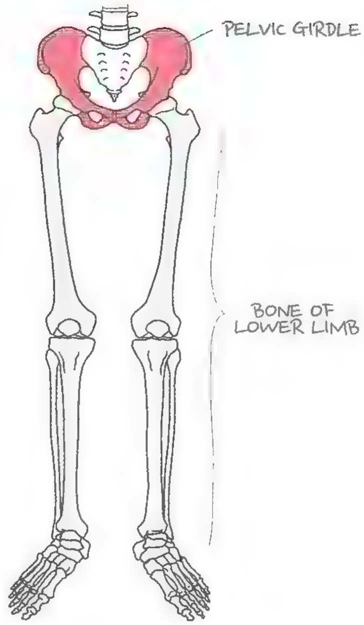
after thinking
with so

te bones

you can see, the pelvis is a structure with ① as the center, where the lumbar vertebrae , with two large bones② that look like giant attached on each side of it. The pelvis is of several parts because it has to adjust rdingly as a person grows older, and though there are also instances (giving birth) where front of the bones② have to 'separate.'

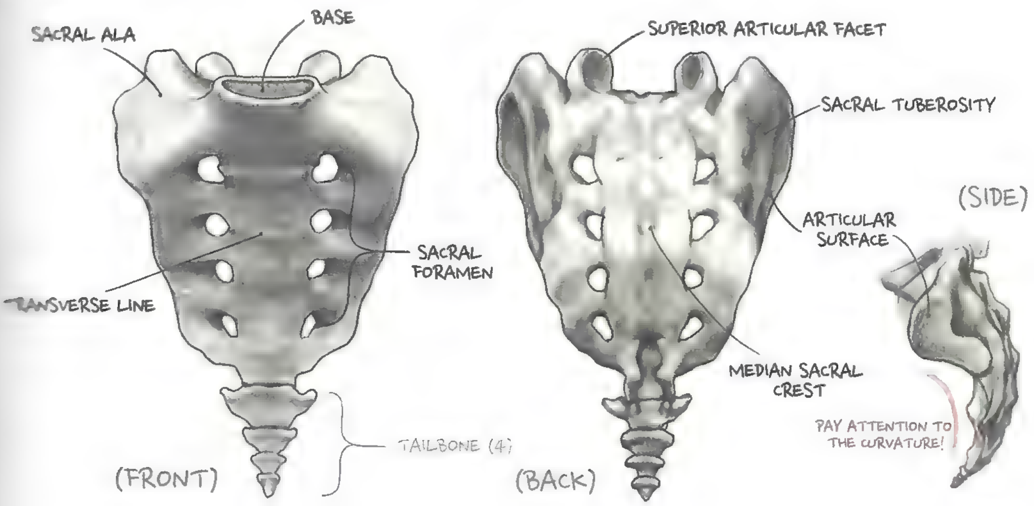
most prominent bone① is the sacrum, es ② on the side are called the hipbone. And use the hipbone holds on to the leg bones, are also called the pelvic girdle, except for sacrum.

then, let's take a look at the 'sacrum' that's g on to the 'hipbones' from the center first.



Sacrum

ically, the sacrum is considered as part of the spinal column. Because it is formed by the ive vertebrae of the lumbar vertebrae suddenly widening and fusing together firmly in order d on to the hipbones on the side. The 'transverse lines' on the center of the sacrum shows of them fused together, and each side of the transverse lines has four pairs of holes called, foramen,' that the peripheral nerves pass through.



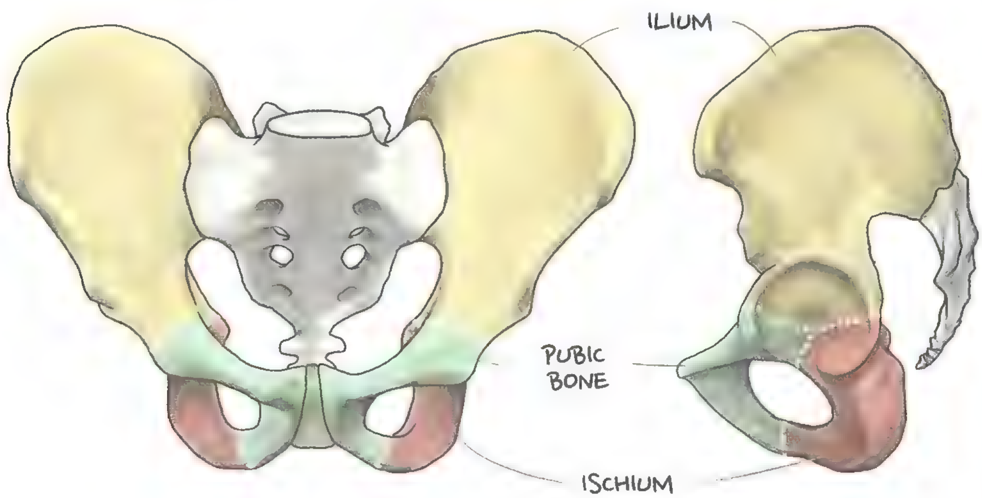
Sacrum, in Latin, means 'sacred,' and it was named so because its decay was the slowest after death and it was thought to be a 'sacred bone.'

The side view of the sacrum is angled and not in a straight line in order to hold on tightly to the hipbones and to secure space within the pelvis.

The four tailbones (coccyx) are attached at the bottom of the sacrum (in the case of vertebrates the tailbone exits to work like a helm, but the 'arm' takes up on that role instead for humans), and because the tailbones are also part of the spinal column that are modified, there are times when the spinal column is considered have a total number of 33 vertebrae (spinal column 24 + sacrum 5 + tailbone 4 = 33) instead of 24 vertebrae.

❷ Hipbone

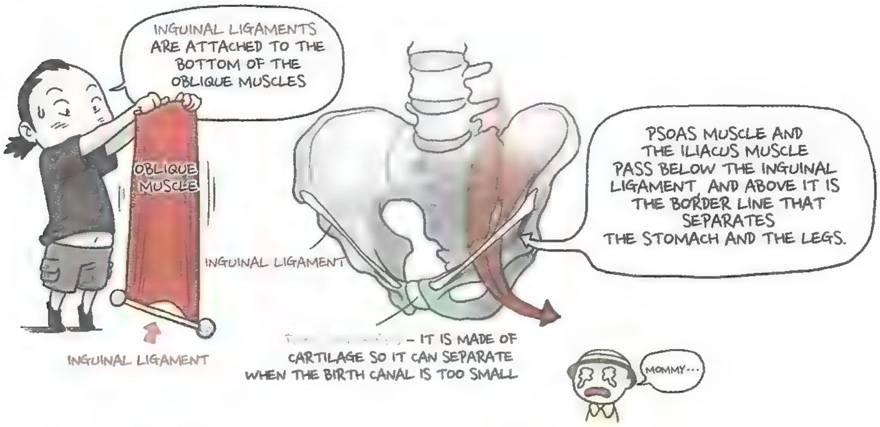
The hipbone looks like one bone at a glance, but it actually is a structure consisting of three bones fused together into one. They are called ilium, pubic bone and ischium, and they are separated into three individual pieces from young child through to adolescence. And then around age 17 they fuse together into one bone. Since they are complicatedly shaped bones they probably need to balance out individually for balanced growth.



***Ilium:** It is generally in a wide and concaved shape, and takes up the most space within the hipbone. Women's hipbones are especially wider and bigger compared to that of men. We'll take a closer look at the physical difference between men's and women's pelvis in p.188.

***Pubis:** The pubic bone, the point where two hipbones meet in the front, are connected by a cartilage—public symphysis, and is protruded outwards so that the muscles and ligaments (inguinal ligament) can attach on

The pubic bone is connected by a cartilage called the 'interpubic disc' in the front, and they get separated and widen in 1 out of 10,000 (1 out of 600 to 20,000 to be exact) natural births.

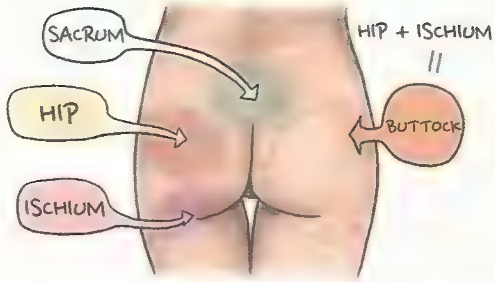


***Hucklebone:** It is formed below the ring-shaped part of the hipbone, and touches the surface when you sit on the floor or on a chair. Humans stand straight and therefore must use their 'buttocks' instead of their 'stomach' to sit, so the lower part of the pelvis has to withstand the weight of the upper body. Think of it as a suspension (shock absorbing device) of a car. Also, many muscles going down the legs are attached to it as well.

Wait! Past Memories about the Hip, Ischium, Buttocks

Ah... Speaking of different areas of the butt, it reminds me of when I was in high school. Nowadays, there is no disciplinary corporal punishment, but back in the days it was the norm. We would get our butt smacked whenever we didn't finish our homework. There was once a little incident like this.

Although I can laugh about it now, it was very confusing at the time. Until then, I didn't know that there were specific areas of the butt such as the ischium and buttocks. It was sort of a culture shock.

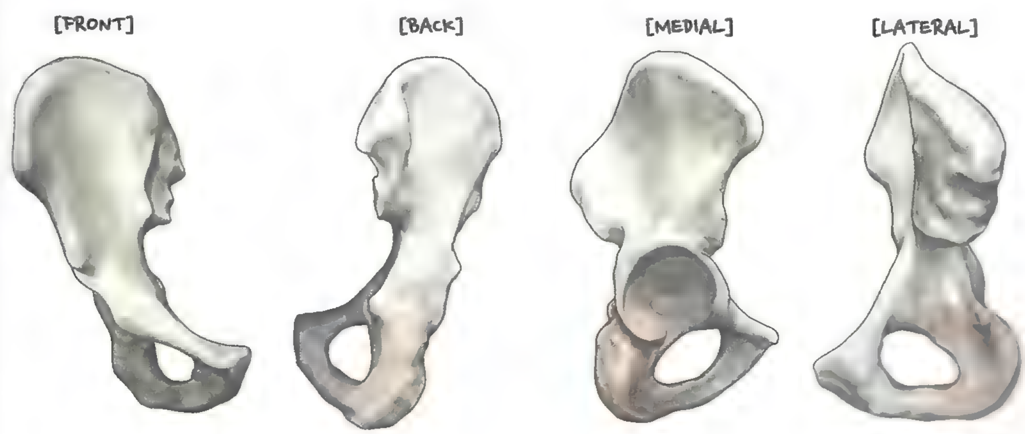


By now you probably have a good idea since we've gone through each bone part earlier, but let's quickly review them.

Sacrum: In the middle of the buttocks, the bony part that can be felt with the hand.
Hip: The top area of the buttock. The ilium takes up the widest part of the hip bone. 'Hip' is often used interchangeably with 'buttock.'
Ischium: The bottom part of the buttock where the ramus of ischium is located. The part that folds when standing.
Buttok: the dictionary describes it as a 'round fleshy part between the waist and thigh.' In other words, it is the part of hip and ischium combined.

Anyways, when my teachers spanked the students, they would say 'stick out your bottom (ischium)!' They said that because that was where the fat layer was thickest and could cushion the blow, and also the part where the fat layer is concentrated really hurts when hit! Also, if the teachers hit more towards the ilium side they might hit the lumbar vertebrae by mistake, and that could be very dangerous. So, my teachers had a reason for saying that they were spanking our bottom out of concern for us.

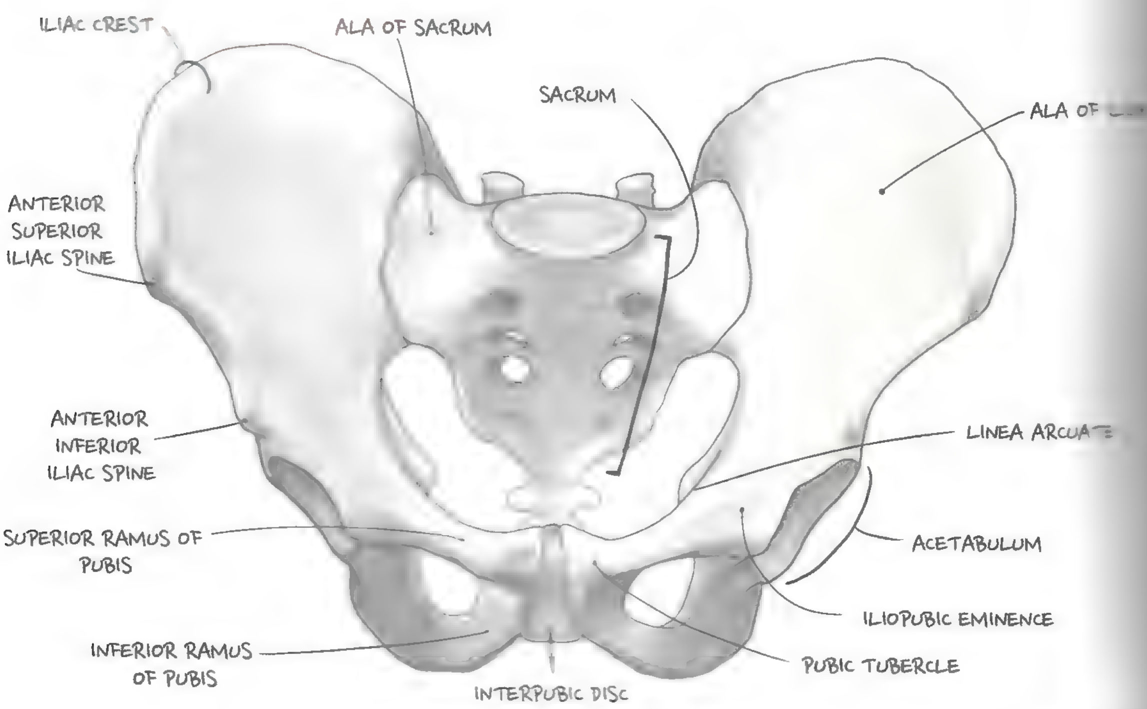
Next there are the various shapes of the hipbone. In the image, I've separated the regions of the ilium, pubic bone (blue) and ischium (red) with different colors, and it is very necessary that you memorize them. You can see for yourself on the next page where there are detailed depictions of the pelvis, but the pelvis has many 'spines,' or 'eminence,' or 'tubercle,' etc. where many parts are sticking out or dented in that it gets confusing if you don't separate them into three different parts. So, please have a good idea of where ilium, pubic bone, and ischium are.



■Detailed Image of the Pelvis and Their Names

From here on, we will be studying the detailed image of each part of the pelvis and their names. There may be some parts that are repetitions from the previous chapter, but please think of the as 'review' and read them. You can never study enough.
Within the pelvis, there is the hipbone which consists of three different bones that take up the most space and has many muscles attached to it. Therefore, it has lots of areas that are protruded out (spine), especially landmarks such as the 'anterior inferior iliac spine,' 'iliac crest,' 'pubic bone,' 'posterior superior iliac spine,' etc. which will be mentioned from time to time even when we cover the muscles, so please keep them in mind.

❶ Front of the pelvis



- **Sacrum:** Please refer to p. 177 for detailed information

- **Ala of ilium:** The ilium consists of the 'wing' and the 'body.' It is literally in the shape of a wing with a wide form, and it is also called the 'iliac fossa' because it is slightly dented inwards to hold the organs. Please refer to p. 178 for information about the ilium.

- **Linea arcuata:** It is one of the structures that act as a boundary line that separates the pelvis major and pelvis minor. It is named 'arcuata' because of its bow-like shape.

- **Acetabulum:** Originated from the Latin for 'vinegar cup.' It is a concaved area where the 'head of femur' goes in.

- **Iliopubic eminence:** Point where the ilium and the pubic bone meets.

- **Pubic tubercle:** The part that starts from the 'anterior superior iliac spine' and connects to the lower part of the 'inguinal ligament.'

- **Interpubic disc:** The area where the pubic bone, the front part of the hipbone, is connected at the front. It is made out of a cartilage. The area where the pubic bone and this cartilage are connected is called the 'pubic symphysis.'

- **Inferior ramus of pubis:** It is connected to the pubic bone, and it is the area where the 'adductor muscle' of the thigh begins.

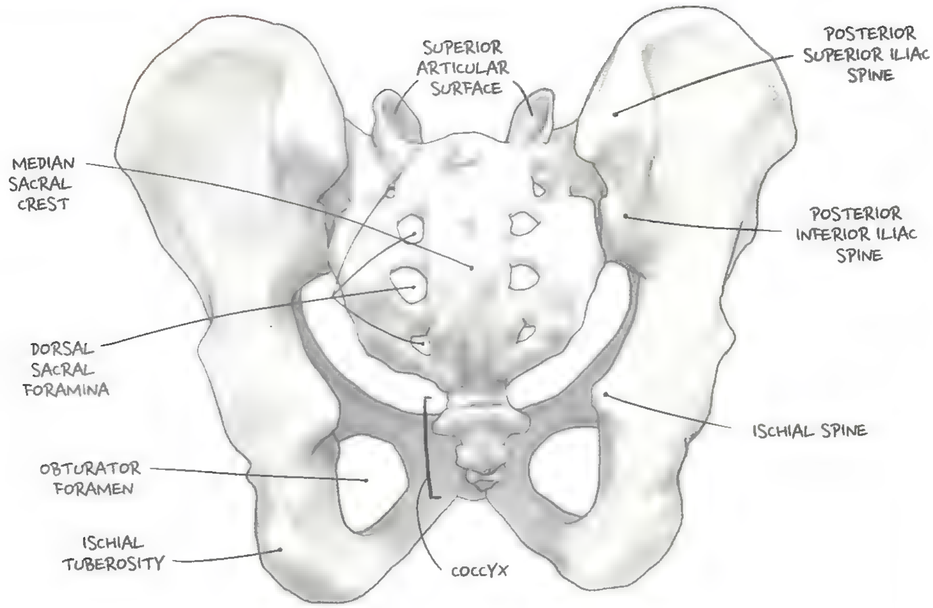
- **Superior ramus of pubis:** The part where the 'musculus pectineus' of the thigh begins, like the 'inferior ramus of pubis.'
- **Anterior inferior iliac spine:** An area where part of the 'rectus femoris muscle' starts.

- **Anterior superior iliac spine:** The part where the 'sartorius muscle' and then 'inguinal ligament' starts. It is easily observed on a woman's waist.

- **Iliac crest:** You can think of it as a boundary line where the upper body and lower body is divided. It is easily observed on the waist of muscular men.

- **Ala of sacrum:** The part where 'ala of ilium,' ② from above, starts. Please don't get confused with 'ala of ilium.'

❷ Back of the Pelvis



❶ **Superior articular surface:** The concaved area where the lumbar vertebrae is connected.

❷ **Posterior superior iliac spine:** The pointy part where the 'iliac crest,' which starts in the 'anterior superior iliac sp... ends at. It is the small dimple on the back of both men and women. It is also referred to as 'Venus's pit.'

❸ **Posterior inferior iliac spine:** The part attached to the 'ligamenta sacroiliaca posteiora' that continues on to the sacrum.

❹ **Ischial spine:** The starting point of the 'sacrospinal ligament' that continues on to the lower part of the sacrum.

❺ **Coccyx:** Literally the degenerated tailbone; it almost doesn't move (please refer to p. 178).

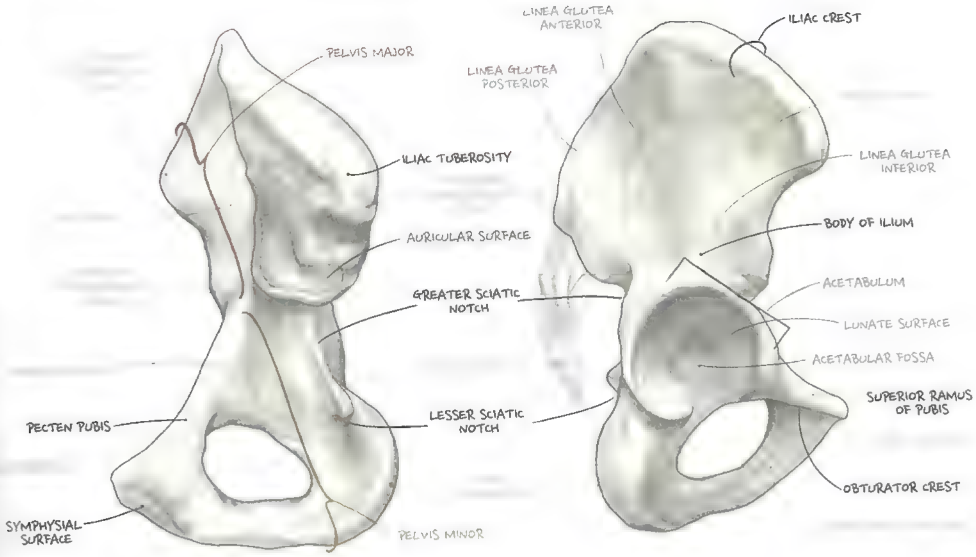
❻ **Ischial tuberosity:** The part that supports the body—the trunk—when seating. Not only does the long section o... 'bicep muscle of the thigh' start here, but so does the 'semitendinosus muscle' and the 'semimembranous muscle.'

❼ **Obturator foramen:** It is a big triangular opening between the pubic bone and the hipbones. Various arteries, ... blood vessels and nerves pass through it.

❽ **Dorsal sacral foramina:** They are the holes that the sacral nerve, which comes out from the spinal cord, reaches ... through the back.

❾ **Median sacral crest:** You can think of it as a trace of 'neural spine' of the spinal column.

The Inside, and Outside of the Pelvis.



- **Symphyseal surface:** The part where the hipbones meet.

- **Pectinate ligament:** The part that makes up the 'linea arcuata' and the 'boundary line.'

- **Greater pelvis (false pelvis) / lesser pelvis (true pelvis):** Using the 'linea arcuata' and the 'pecten pubis' as the boundary line, the upper part is called the 'greater pelvis (false pelvis)' and the lower part is called the 'lesser pelvis (true pelvis).' There may be some confusion as to how 'greater/lesser' and 'false/true' matches, but it will make sense if you compare the pelvis to a 'basin:' the bowl region (lesser pelvis) would be closer to its actual function instead of the handle (greater pelvis).

- **Iliac tuberosity:** The part where the 'sacral ala' touches.

- **Auricular surface:** The part where the 'auricular surface (same name)' of the sacrum attaches.

- **Greater sciatic notch / lesser sciatic notch:** It's not referred to as a specific region, but the opening that formed due to the ligaments (sacrospinal ligament, sacrotuberal ligament, etc.) head towards the sacrum, starting from the 'ischial spine' and the 'ischial tuberosity.' It is also considered an 'opening' sometimes instead of a 'notch,' considering how the ligaments are attached.
- **Posterior / anterior / inferior gluteal line:** The lines where the 'gluteus muscle' starts. Posterior - gluteus maximus muscle / anterior - gluteus medius muscle / inferior - gluteus minimus muscle start accordingly.

- **Body of ilium:** The body part of the ilium, along with the 'ala of ilium', that forms the ilium.

- **Acetabulum:** The part where the 'head of femur' goes in.

- **Lunate surface:** The section inside the 'acetabulum' in the shape of the crescent moon covered by cartilage.11. Acetabular fossa: It is surrounded by the lunate surface, and is the part connected by the 'head of femur' and the 'ligament.'

⑪ **Acetabular fossa:**t is surrounded by the lunate surface, and is the part connected by the 'head of femur' and the 'ligament of head of femur.'

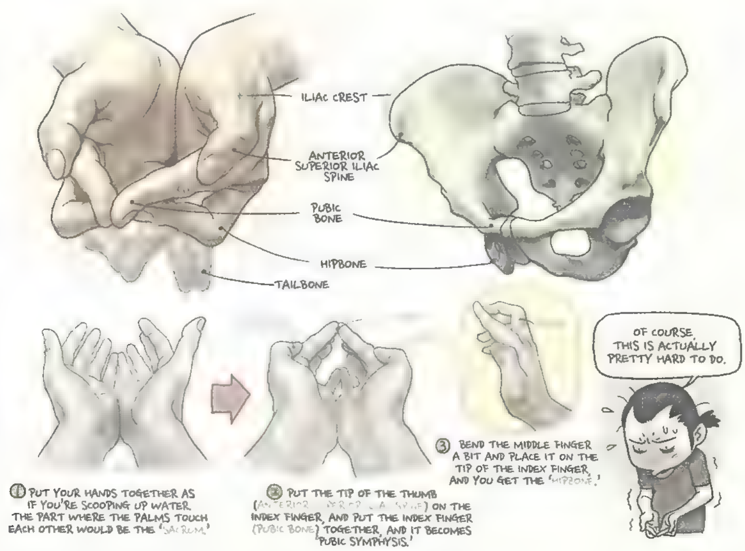
⑫ **Obturator crest :** The part where the 'ligament pubofemorale' starts and continues from the 'pubic tubercle' and the 'acetabulum.'

Wait! Still don't get it?

We've taken a look at the various parts of the pelvis. However, it's not easy to understand it with just the book alone. That's because no matter how simply I try to explain it, the images on the book are in 2D while the actual pelvis is in 3D (It's not like we can use the hologram...).

Of course, the best way to study it is to observe and touch the actual model of a pelvis, but it wouldn't be easy to get a hold of one.

The fortunate thing, at least, is that anyone can make a 'portable model of the pelvis' using their two hands. Of course, it is not comparable to the real specimen or model, but it is still a good way to understand it three-dimensionally, so try to copy the image below with your own hands.



(This method has no official name, so let's just call it the 'hand pelvis.')

This may look difficult when you look at it, but it is not that hard when you actually try it (you might have some difficulty if you have short fingers like I do ^^). This is somewhat sloppy, but it is a way to effectively remember the landmarks, so only use it as a reference.

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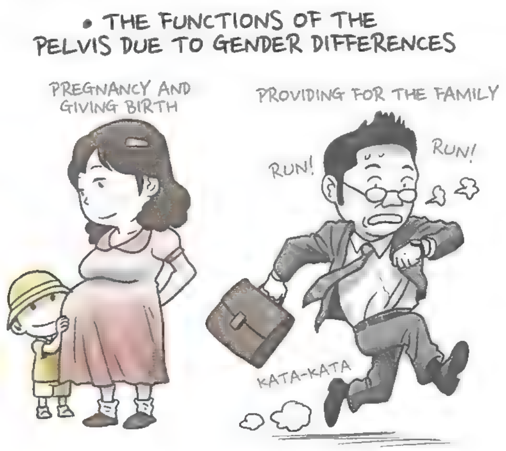
■Shake Your Butt

We've taken a look at the general shape of the pelvis, but the real fun starts now.
To mention the conclusion first, the physical appearance of the body depends on the pelvis. You might think that pelvis is just one of many pieces of bones that constitutes a body, but the reason is simple if you think about it.
The physical appearance of all animals depends heavily on the environment they are living in, and on which part of the body becomes their main means of transportation. Since humans stand straight and have to use their 'legs' as a way to move around, it is only natural that the overall appearance of the body depends on the shape of the pelvis, which is the starting point of the legs.

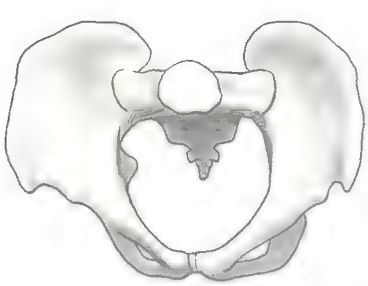
But these physical differences aren't affected by external environments alone. Internal environment, meaning the different roles of each genders also affect the body's appearance.



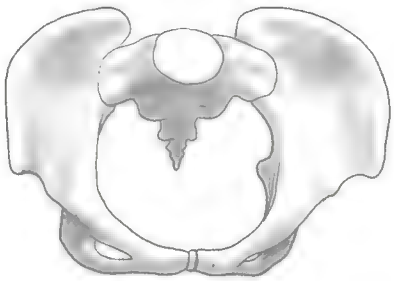
Even if we're all human beings, the shape of the pelvis changes depending on the difference in fundamental roles based on gender. As a result, this difference affects the overall appearance of the body as well. In other words, the difference in their physical role affects the appearance of the pelvis, and both the male's and female's unique appearances are determined by those differences. In short, there is a reason why males look like males and females look like females. Makes you think that there is nothing random in this world.

■The Secret of Curves

Of all the bones that constitute the body, the pelvis is where the difference between men and women is most prominent. Next are images of the typical male and female pelvis as seen from the top.



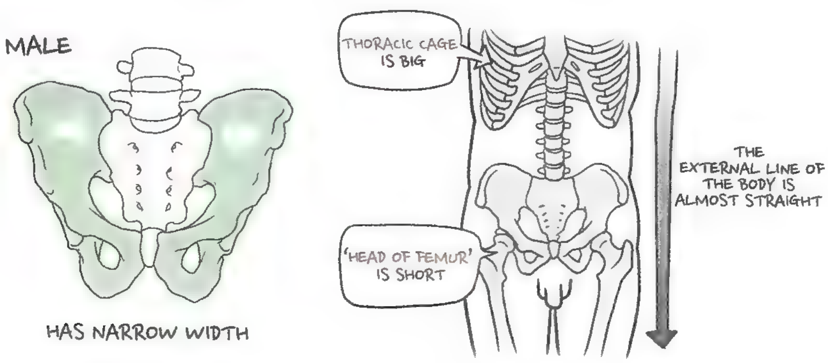
android pelvis



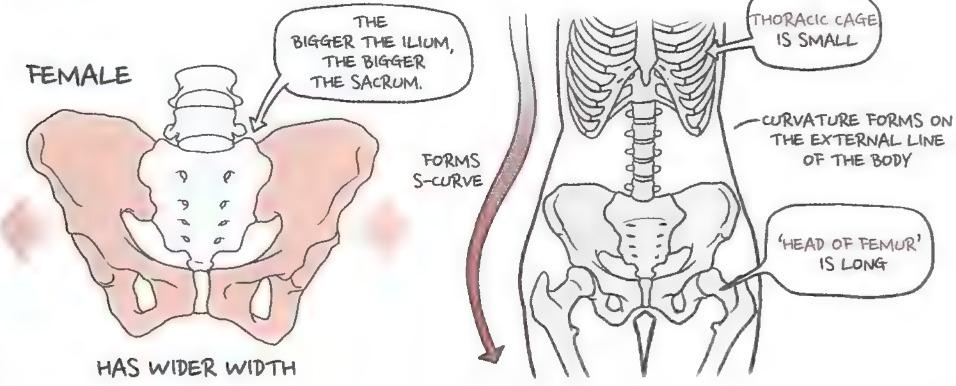
gynecoid pelvis

Hmm, the male pelvis is generally narrow, and the female pelvis is wide. …is that it?
We would miss a lot if we just took a cursory glance and moved on. We need to explore the fundamental reason why such differences exist at all in the first place, but first, let's see exactly what kind of influence it has on the physical appearance of the body.

I've mentioned earlier that the male's heart and the lungs are bigger than the pelvis. The male 'thoracic cage' is relatively bigger and the head of the femur (refer to p.462) that connects the pelvis and the femur tend to be short and wide. So, the external line of the body doesn't have that much curvature.



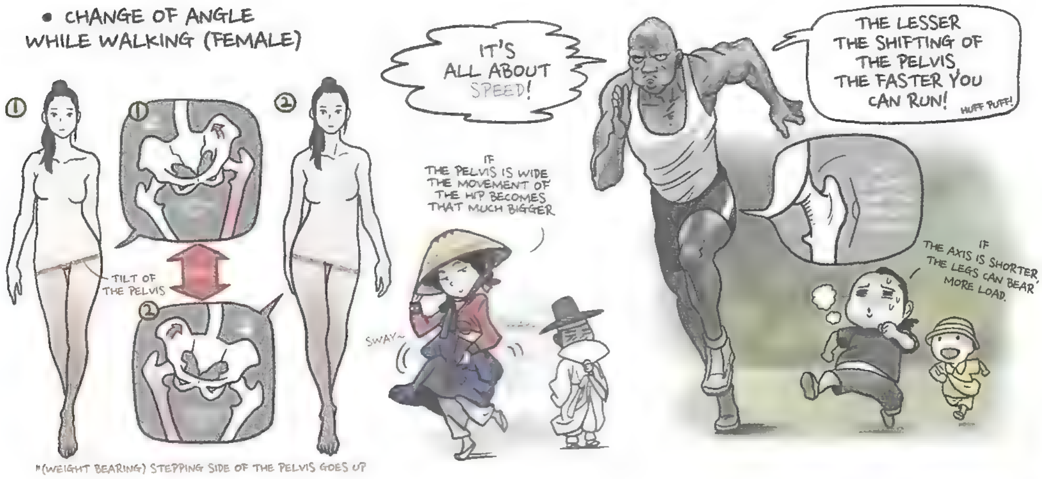
By comparison, the female's wider pelvis contrasts with the relatively smaller thoracic cage to create a curvature of the body that Koreans call an S-curve, in which a longer 'head of femur' also plays a part.



As you can see, the reason why the female pelvis is bigger and wider compared to that of a male, is because females get pregnant and give birth. It is only natural that the pelvis has to be big and wide if it is to securely hold the organs and the baby.

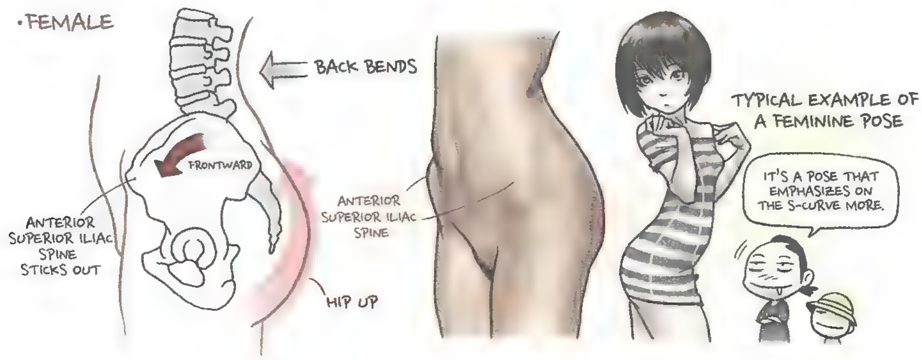
The female's big pelvis and 'head of femur' affects their 'stride,' the act of alternately shifting weight on each leg. The hips waver a lot since the pelvis is wider, think about when men imitate the way women walk.

In contrast, because males do not get pregnant, the structure of their narrower pelvis and shorter head of femur are more optimized for movements such as 'walking' or 'running,' etc. like their thoracic cage. This is why men run relatively faster than women.



Not only can you see the differences in the size and the width of the male and female pelvis from the front, but there are more drastic differences in the 'tilt' from the side. The reason why sticking out the lower body like the picture below has a masculine image is because the pubic bone rises upwards. This is so that males can perform active sexual intercourse and also to straighten out their spinal column so it can bear the big thoracic cage more securely.

On the contrary, the female pelvis sinks downward to secure a comfortable space for the baby, and this causes the anterior superior iliac spine that is above the ilium to protrude out. It also means that the tailbone rises naturally, and thus the lumbar vertebrae bends inward. Therefore, contrary to males, their hips stick outwards, emphasizing the 'S-curve,' resulting in a pose unique to females.



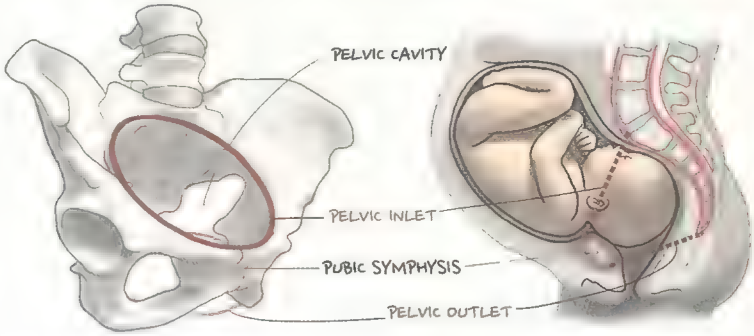
Men and women get different landmarks on their waist due to differences in this kind of tilt. In the case of males, the line that runs through the 'crest of the pelvis' to the 'pubic symphysis' is prominent, while for females, the protrusion of the 'anterior superior iliac spine' is more prominent. Please keep these in mind if you are an artist, because these different landmarks in the pelvis is what distinguishes the differences between male and female when drawing them.

Author's male and female nude figure drawing (2009 ~ 2010).
Please pay close attention to the part where the 'iliac crest' of the male's pelvis and the 'anterior superior iliac spine' of the female are emphasized on the waist.

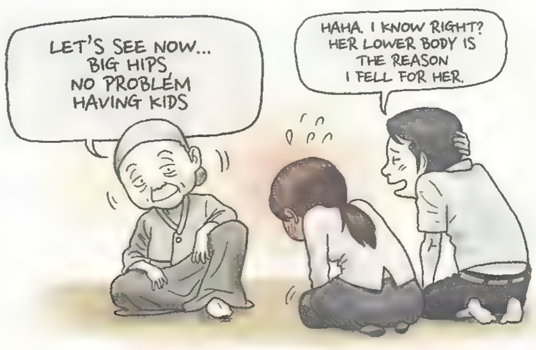
Wait! Pathway of the pelvis

"Some of the biggest characteristics of humans is standing upright to walk on two legs (bipedalism) and the development of the cerebrum. We are able to perform various tasks with the hands, as there is no need to support the weight with the arms. But as the pelvis had to bear the entire weight of the body, the pelvis became sturdier compared to other vertebrates, but the birth canal became narrower. Moreover, the infant's head grew bigger as a result of the development of the cerebrum, and giving birth became more difficult because the infant couldn't be born without having to forcefully squeeze through the birth canal." –〈Excerpt from Laboratory Manual of Human Osteology〉

As you can see from the excerpt above, the process of giving birth is unimaginably difficult and painful for both the mother and the baby. The birth canal, meaning the pelvic inlet/outlet and the pelvic cavity, is the pathway for the baby. The problem is that this space is barely big enough for the baby's head to come out (that is why the baby's skull, which is not yet fully fused, has to squeeze for it to come out). If the mother has a small pelvis, it would be dangerous for both mother and the baby.

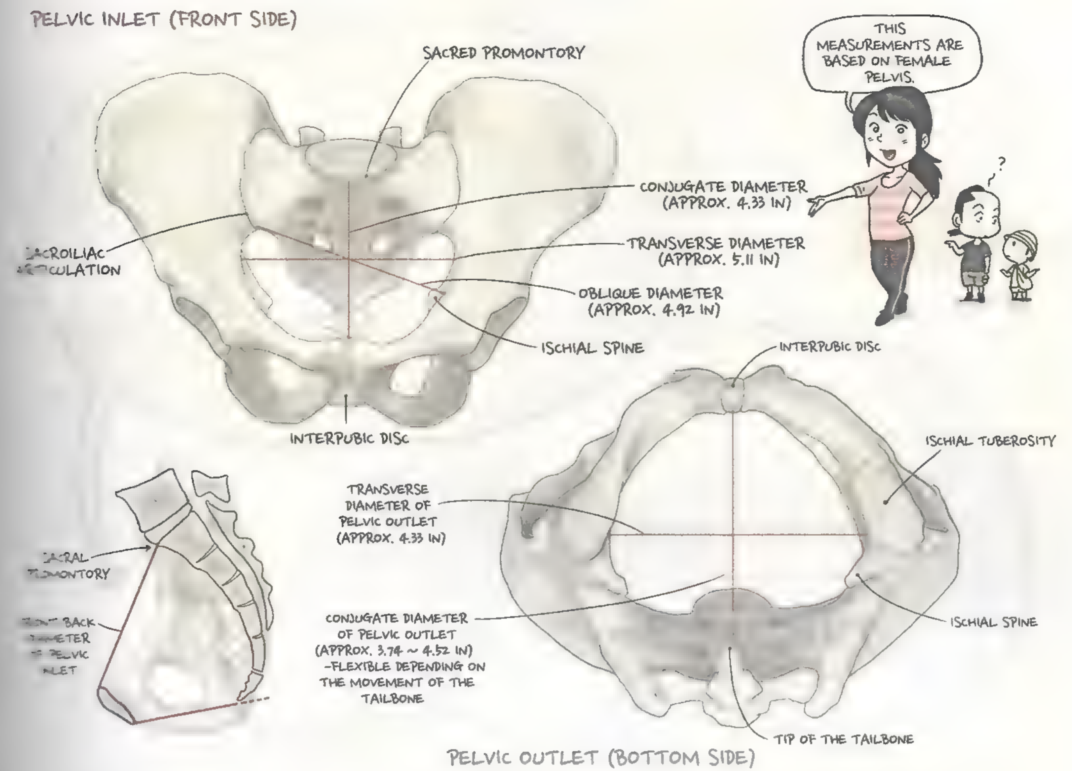


Nowadays, delivery became much safer with alternative ways to natural birth, such as the caesarean section (c-section). But back in the days when medical technology wasn't so advanced, people had a tendency to choose women with 'big hips' who wouldn't risk the danger of death during delivery. (However, a big hip doesn't automatically equate having a big pelvis; the method of delivery is determined by the size of the pelvic inlet and outlet instead of by the exterior appearance of the pelvis.)



During the times when offspring were considered valuable, women with big hips who were thought to give birth without much problem became the 'basis of beauty' across all ages and countries, and this basis is still valid today. People are naturally attracted to the opposite sex who have features that they themselves do not possess.

FYI, let's take a closer look at the average size of the 'pelvic inlet' and 'pelvic outlet.'



His and Her Pelvis

The difference in the appearance of the pelvis based on gender has significant effect not only on the angle of the arms and the legs but also on the overall appearance and movement of the body. Also, as I mentioned earlier, because it is very closely related to the thoracic cage and spine, it becomes an important basis for 'poses' specific to each gender.

These characteristics were very important observation and depiction points for artists that had to express the male and female characteristic through still images. Please refer to the following images.

DRAWING MEN

THIS SYMBOL (PICTOGRAM
EMPHASIZES THE UPPER BO
(THORACIC SKELETON)
OF MEN
THIS SIGN IS UNIVERSALLY USED FOR THE MEN'S RESTROOM
BATTLE ROBOTS' BASIC STANCE IS TO OPEN THE CHEST AND PUSH OUT THE PUBIS.
ARMS HAVE OUTWARD ANGLE BECAUSE OF WELL-DEVELOPED CHES (PECTORALIS MAJOR) AND BACK (LATISSIMUS DORSI)
WHEN YOUR UPPER BODY MUSCLES ARE WELL-DEVELOPED, THE ARMS FALL AWAY FROM THE TORSO.
PILLOW
THE LEGS START OUT FROM A NARROW PELVIS AND SPREAD OUT.
NARROW-WIDTH
LEGS SPREAD OUT
IN COMIC BOOKS, CHARACTER FORMS ARE EXAGGERATED BY EMPHASIZING THE THORACIC SKELETON WHILE THE PELVIS AND LEGS ARE MADE SMALLER.
MY LEGS AREN'T REALLY SHORT. GRRR...
IN ADDITION TO HAVING A NARROW PELVIS, THERE ARE OTHER REASONS MEN SPREAD THEIR LEGS.
STILL ANNOYING IN THIS CASE
● TO PROVIDE A STABLE SUPPORT FOR A RELATIVELY LARGER UPPER BODY.
● FOR THE SCROTUM (TESTICLES) TO PRODUCE SPERM AND PRESERVE THEM ETC.
WE CAN'T STAND TEMPERATURES OVER 93.2°F
WE DON'T LIKE SKINNY JEANS

DRAWING WOMEN

The width of the pelvis creates the "carrying angle" and a unique 'Q-angle' is created with the legs. This plays an important role in depicting a feminine appearance. Further explanation will be given on page 334, 474

The following pictures show the external surface of the male and female pelvis. In the case of the muscle above the pelvis is developed and this is expressed with the sunken 'iliac crest.' For women, the 'anterior superior iliac spine' protrudes. As for the back view, both male and fema 'posterior superior iliac spine (a.k.a. dimples of venus)' are sunken in albeit with some differen This is an important feature in men's and women's bodies, so observe closely the difference between the two.

The male (left) and female (right) pelvises have different characteristics. The level of muscle development and fat distribution surrounding the pelvis determines how parts of the pelvis protrude or are sunken.

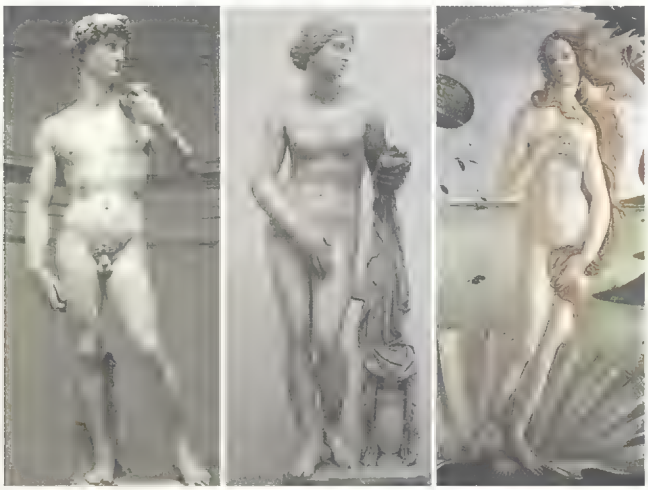
wait! contrapposto

There is an important 'posture' in anatomical drawing that we need to discuss when talking about the different postures formed by the pelvis. But first, let's take a look at the pictures below. What do you think of them?

Sculpture of a young female figure 'kore' and young male figure 'kouros' from 6 BC

Although the sculptures are beautiful, they are somewhat rigid and unexciting. These ancient Greek sculptures are from 6 BC (Archaic period). These sculptures were influenced by ancient Egyptian art characterized by their symmetrical and static pose.

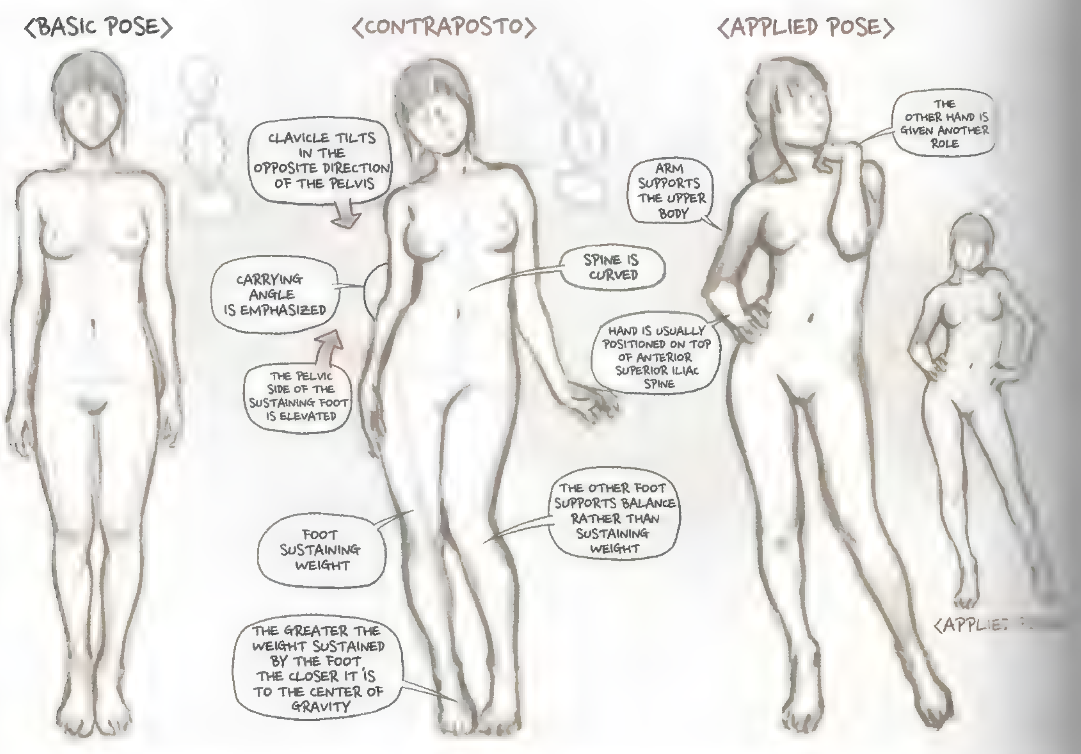
Then, in 4 BC, a great change swept across ancient Greek art. All of the artwork shown below are well-known to us. What common anatomical characteristic can you see?



From the left: David by Michaelangelo, Aphrodite of Knidos, The Birth of Venus by Boticelli

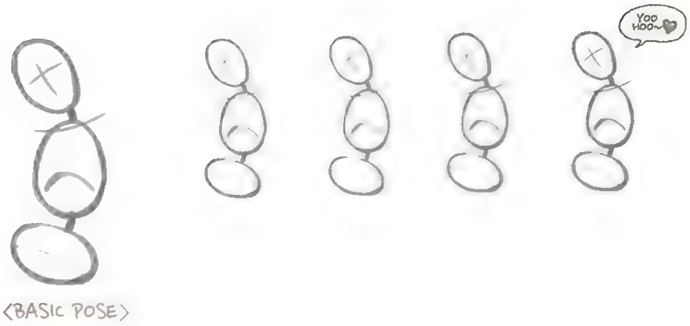
Some of you might have already noticed that the figures are leaning their weight on one leg. Though common nowadays, this pose was a visual shock at the time when these artworks were first created, rightly so. Standing with just one knee slightly bent brings much more liveliness compared to the human form of the Archaic period.
This pose did not come about out of the blue; it is a careful aesthetic calculation. It is called 'contrapp which means 'to contrast' in Italian.

The term 'contrapposto' may sound difficult, but it simply means to put most of the body weight on one while the other leg is relaxed. This seemingly small movement tilts the pelvis, and the rest of the body to twist in different angles to balance in 'contrast' with the pelvis. The body instinctively tries to rest balance whenever balance is affected. As a result, shaking the balance a little paradoxically emphas the beauty of the balanced body.



'Contrapposto' was first applied to male figures. It began to be applied to female figures around 4 BC Praxiteles first used this method on his Aphrodite of Knidos (in painting, this method was first applied Boticelli's The Birth of Venus).

This pose actually emphasizes the female figure which has a more developed pelvis. That is why this was popularly used for centuries by artists and photographers as a formula to express the female fe Therefore, anyone studying to draw the human figure should become familiar with 'contrapposto.' I explain more about how to apply 'contrapposto' in the practice part later.

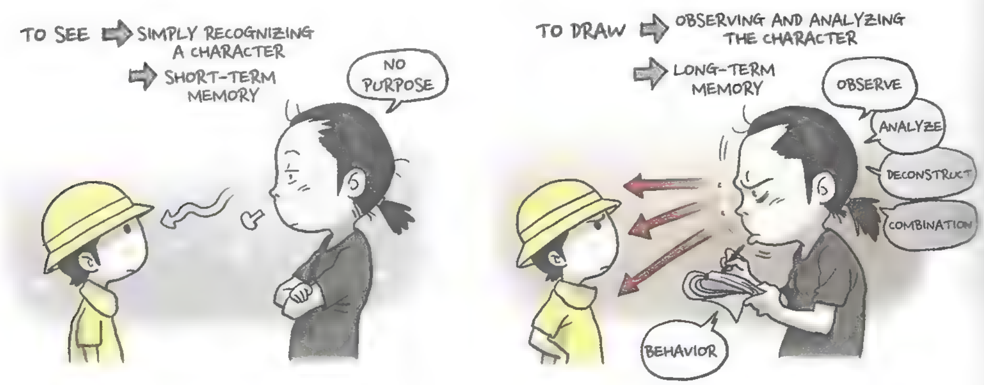


'Leny' (partial – promotional work done for Lenovo laptop) / painter 12 / 2016
Just by applying 'contraposto,' you can bring out the liveliness of the female character without any flashy pose.
Although it is a small movement, the effect is so powerful that many mass media such as advertisement or photography consider it as the basic rule.

■Let's Draw the Pelvis

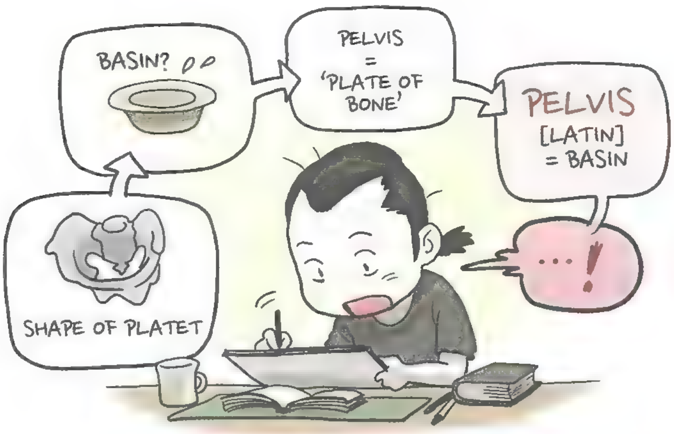
Once again, it's drawing time. We already drew the head and torso, so it shouldn't be difficult to draw the pelvis. However, I'm sure there are some of you who still haven't mustered the courage to draw. I have seen many such students. When I ask them why they won't try, they often tell me the following reasons.

Although this book is an art anatomy book with the purpose of 'drawing the human body we I recommend that you give it a try, even if you are not good at drawing. When you observe a character and try to draw what you see, you will find yourself observing more carefully, and t has a repeated learning effect. In other words, drawing is not just a form of 'recording,' but it a serves as a cognitive tool to remember certain information.



In both cases, you are 'looking at' something, but when you have the specific purpose 'to draw,' you will start to notice details you hadn't previously, and because you are actively working your brain, you will remember for a longer time. In both cases, you are 'looking at' something, but when you have the specific purpose 'to draw,' you will start to notice details you hadn't previously, and because you are actively working your brain, you will remember for a longer time.

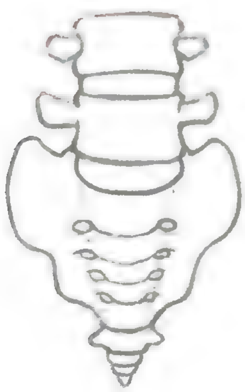
...ause the pelvis has many functions, it also has much related data to be memorized (in fact, ...omy is all about memorizing). You will start to panic if you try to study the words and pictures ...arately because that means you will be memorizing two things. The most effective way is ...memorize the words and pictures as one. This is where 'drawing' comes in useful. It is like ...ociating an image or visual story to a new vocabulary you are trying to memorize. ...en you take time to draw, you often learn things you had not noticed before.



Dictionaries are essential when studying anatomy (both Chinese character and English dictionaries)

...at is why it's not important whether you have talent in drawing or not. From now on, let go ...the worry that you need to be good at drawing. Think about which part of the body you are ...ng to draw and what the name is, and then draw that part while trying to memorize the name.

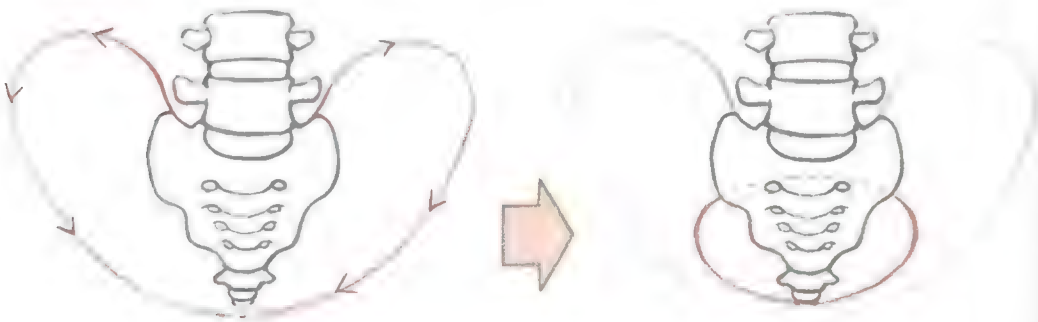
Drawing the front of the pelvis



01. First, let's draw the sacrum which is the beginning of the pelvis. Rather than draw the sacrum right away, it is easier to first mark the line that extends from the fourth and fifth lumbar vertebra above the sacrum to the coccyx then draw the wings on each side. The sacrum is more of a vertebra transformed to hold the ilium. The coccyx below the sacrum is usually made up of three to four bones.

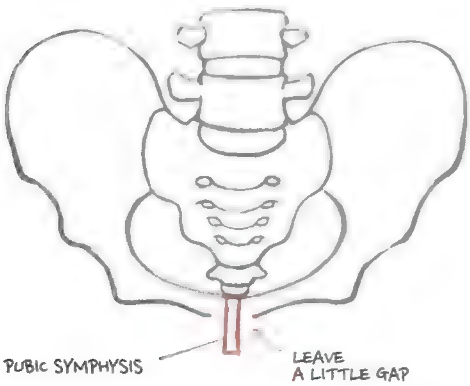
02. Now that we have drawn the sacrum which is the starting point of the pelvis, we will now draw the 'hip bone.' I already mentioned that from the front view, the hip bone consists of the ilium, pubis, and ischium. (refer to page 178) First, draw the line that runs from the ilium to the pubis.

① First, start with the 'ala of sacrum' and draw a wide heart shape around it. The bottom part of the heart should meet at the bottom of the coccyx.
② Inside the heart shape, draw a wide oval shape. This is called the terminal line.



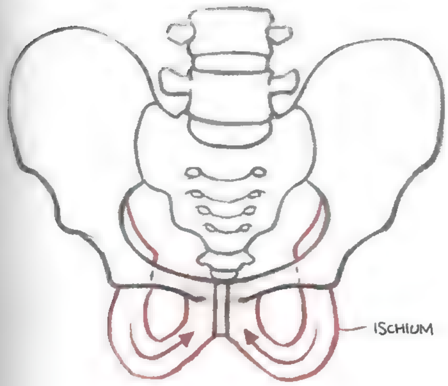
03. On the outer periphery, mark three projecting parts as shown on the left. Starting from the top, these are the locations of the following parts

1 : Anterior superior iliac spine
2 : Anterior inferior iliac spine
3 : Iliopubic eminence

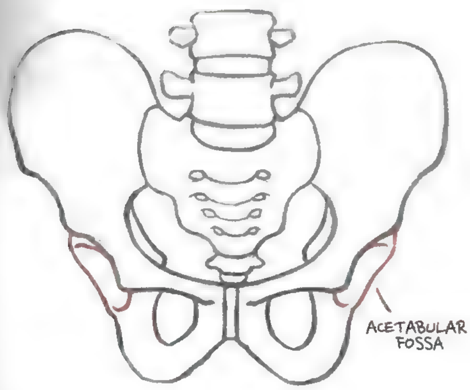


04. In the middle where the pubis meets, mark the pubic symphysis. This part is a cartilage.

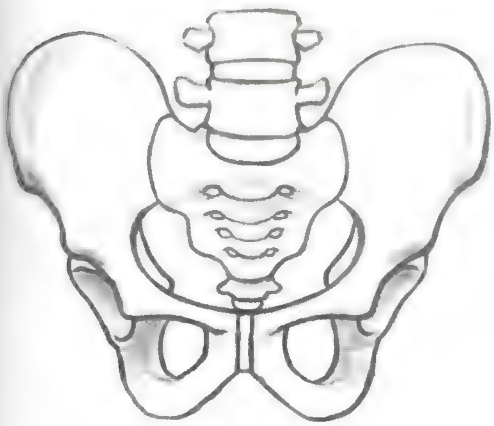
This is where the ischium will be added in the next step, so the point is to draw it slightly lo



05. Draw a 'U' shape loop that starts from the back bottom of the terminal line and gathers towards the pubic symphysis in front. This loop is called the ischium. Once we draw the ischium, the drawing becomes more like the pelvis we know.

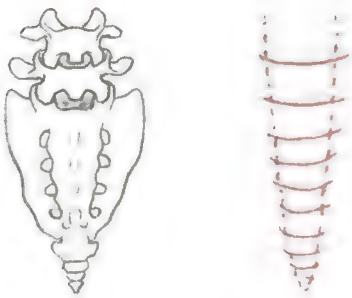


06. On both sides where the hip bone and ischium are connected, draw the acetabulum (acetabular fossa). The acetabular fossa is occupied by the head of femur.

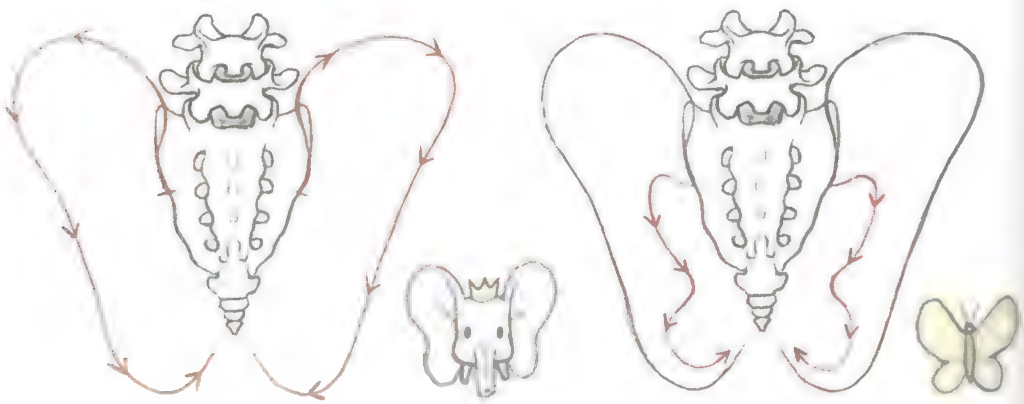


07. Shade in the back parts or sunken parts to express the dimensions of the curves. This will not only improve the drawing, but it is also an effective way to better understand the dimensional pelvis.

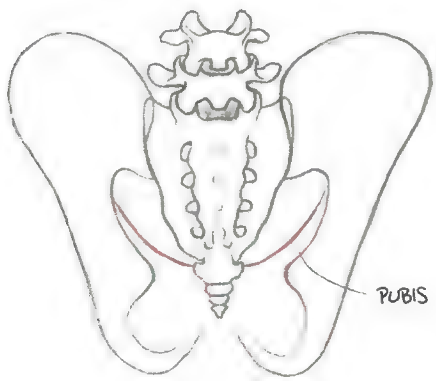
❷ Drawing the back of the pelvis



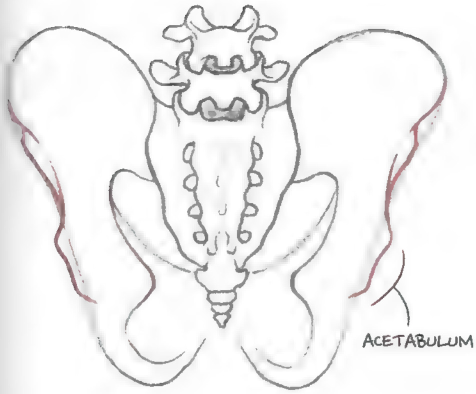
01. Just like with the front view, first draw the sacrum that is connected to the fourth and fifth lumbar vertebrae. The back view might be a little more difficult to draw because of the lumbar vertebrae but in the same way you drew the front side, it will be easier if you distinguish the column and the wings.



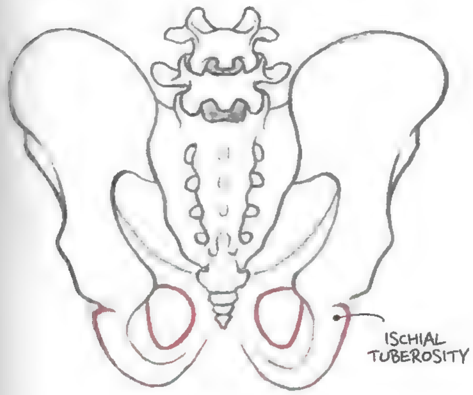
02. Starting from the sacrum, draw the overall outline of the hip bone from the ilium to ischium. The outer line resembles an elephant's ears, while the inner line resembles a butterfly.



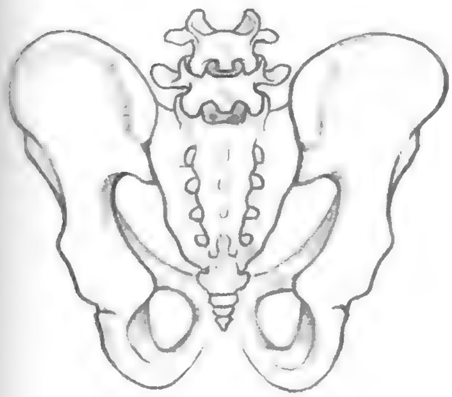
03. Draw the pubis that connects towards the front. At this point, the pubic symphysis will not be visible because it is behind the sacrum.



04. On the upper sides of the ilium draw curves, and on the lower sides that lead to the ischium, add the acetabulum.

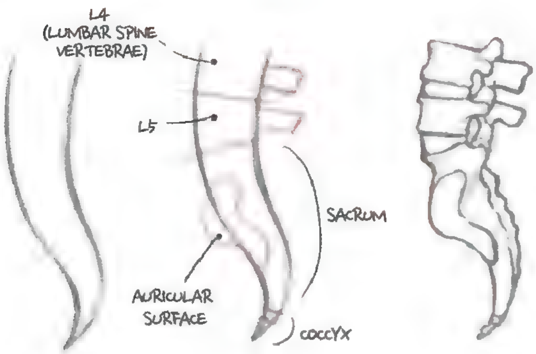


05. Once you draw the ischial tuberosity at the back of the ischium (front of this picture) and obturator foramen, you are almost done.

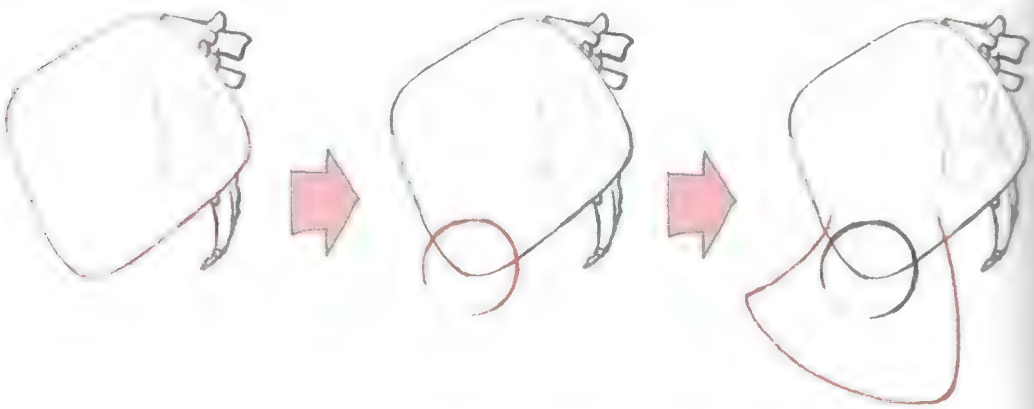


06. Just as we did when drawing the front view, use a pencil to softly shade in the curves.

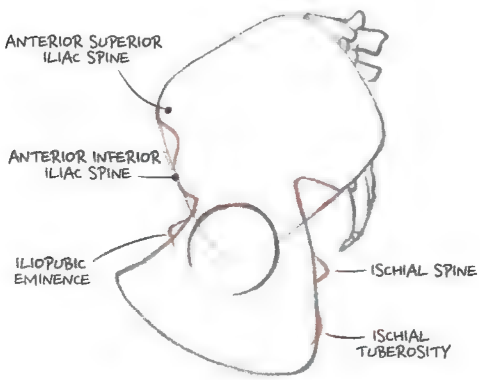
❸Drawing the side of the pelvis



01. Draw the lumbar vertebrae and sacrum as seen from the side. This will be covered by the hip bone we will be drawing next, but drawing it will help you to become familiar with the structure.



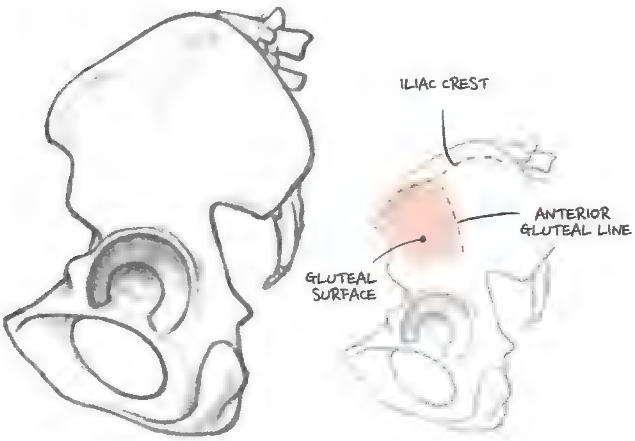
02. This is a rough outline of the ilium -> acetabulum -> ischium.



03. At the front of the pelvis, draw the protruding that are the anterior superior iliac spine, anterior inferior iliac spine, and iliopubic eminence.
At the back of the pelvis, mark the sunken part between the ala of ilium and body of ilium, then mark the curves of the ischial spine and ischial tuberosity.

04. At the ischium area, draw an obturator foramen that looks like the number '6.' Since it overlaps with the bottom of acetabulum, the acetabulum will look like the bottom has been cut off.

05. Once we draw the curves on each part of the acetabulum—the acetabular margin, lunate surface, acetabular fossa, and ischial tuberosity at the bottom of ischium—we will be almost done.

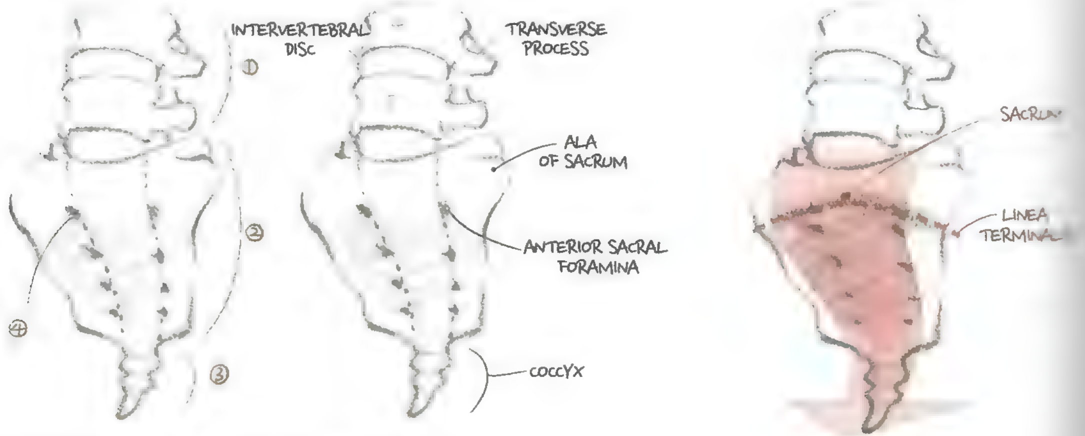


06. Areas that surround the ilium's 'anterior gluteal line' are difficult to express in lines, so use shading instead. These areas are the gluteal surface and iliac crest.

❹Drawing the three-dimensional pelvis (front)

Now that we have warmed up, let's draw a three-dimensional pelvis. The 'half side' view point is the best way to understand the dimensional shape of the pelvis. We will try drawing the pelvis from the 'half side.' Based on what you have drawn before, let's get into further details.

01. First, we will draw the sacrum that forms the basis of the pelvis. Remember that the sacrum is part of the lumbar vertebrae (refer to page 176). Therefore, st by drawing the end of the lumbar verterbrae like a snake tail or tip of the brush. Later on, this will bec the coccyx.



02. Based on the sketch line drawn before,

① Distinguish the lumbar vertebrae and intervertebral disc in drawing.
② Draw the 'ala of sacrum' like ears on each side.
③ Roughly outline the coccyx.
④ On both sides of the original sketch line, mark four pairs of holes (anterior sacral foramina). This roughly completes the sacrum.

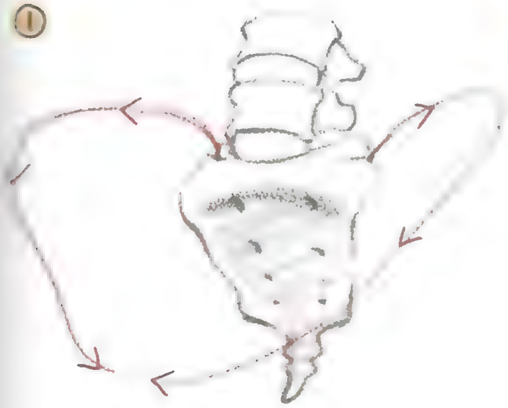
Be careful to draw the 'S'-shaped curve at the sacrum. The sharp 'S' angle above is where the nea terminalis starts.

33. Now, we will draw the 'hip bone.' I explained previously that the hip bone consists or the ilium, pubis and ischium (refer to page 178). First, draw the line connecting from the ilium to pubis.

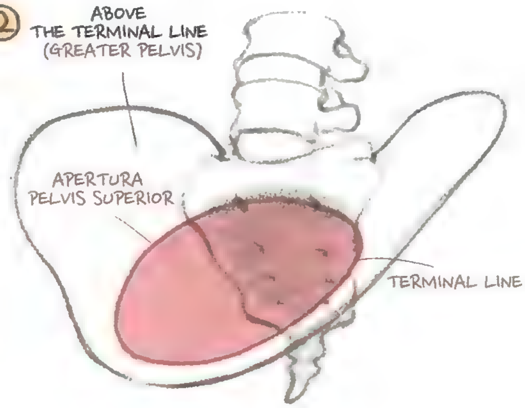
① First, start from the 'ala of sacrum,' and sketch a wide and flat ear-shaped circle that meets at the front. The points where the two lines meet will later become the 'pubic symphysis.' In the 'hand-imitation of pelvis,' this would be where the index fingers meet.

② Within the sketched line, draw a circle for the 'terminal line.' The plane surface inside the terminal line is the 'apertura pelvis superior.' The broad bones located above the 'apertura pelvis superior' is called 'greater pelvis' or 'false pelvis.'

①

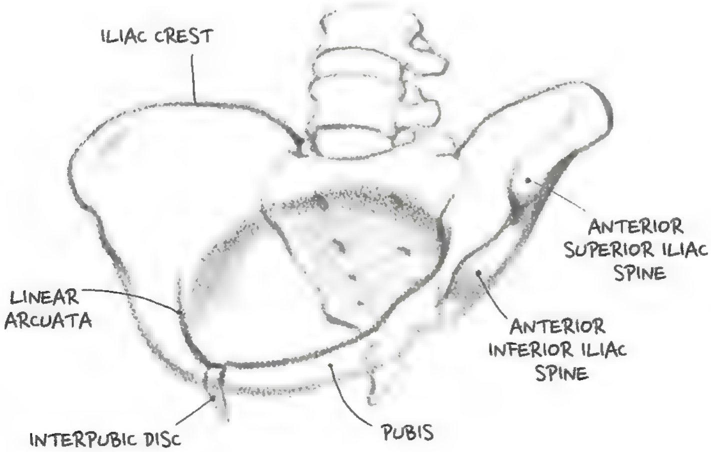


②



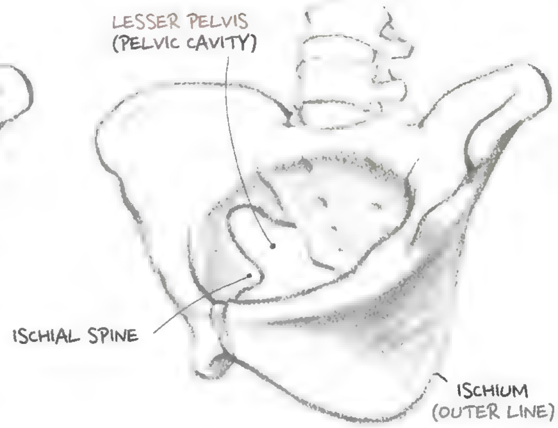
The greater pelvis supports the digestive organs.

③ The next picture is based on what you have sketched so far. It will add details to the 'greater pelvis.' The anterior superior iliac spine is the most important landmark, so we need to sketch this carefully. The interpubic disc at the front should be longer than the joint. The coccyx will be hidden behind the pubis, so erase the part that overlaps.



04. Just as there is a 'greater pelvis,' there is a lesser pelvis. The 'lesser pelvis' is located below the 'apertura pelvis superior.' In other words, you can think of it as being formed by the ischium. That means that in order to draw the lesser pelvis, you need to draw the ischium.

The ischium starts below the terminal line of the sacrum and gathers at the interpubic disc at front. In the 'hand-imitation of pelvis,' this would be where the middle fingers meet (refer to page 186).



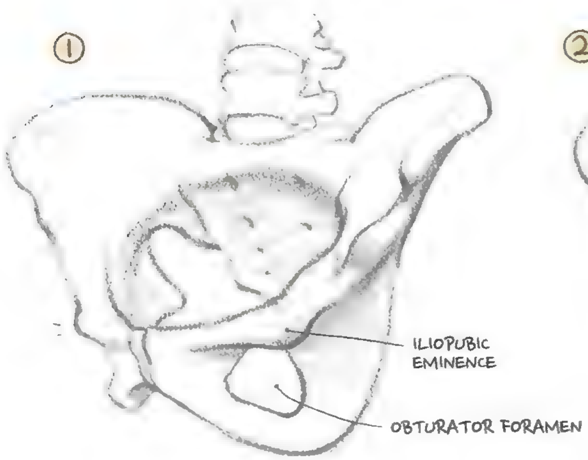
The lesser pelvis holds the urinary bladder, reproductive organs, rectum (the part from the large intestine to the anus), arteries and nerves.

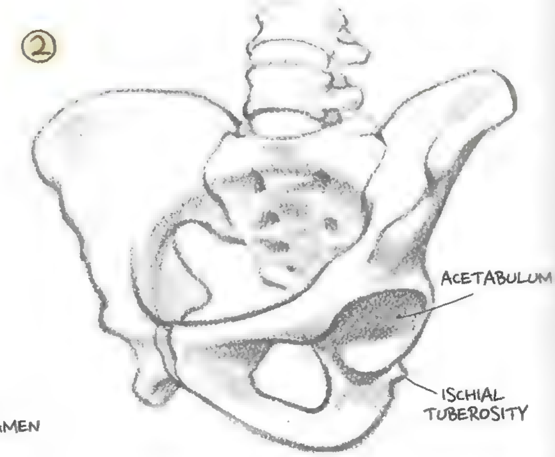
Once you sketch the sharp ischial spine at the back, this forms the lesser pelvis that is the hollow part below the terminal line. This part is also called the true pelvis, or pelvic cavity.

05. Wrapping Up

① Draw the 'iliopubic eminence,' which is the projecting part where the ilium and pubis meet. Draw a triangle in the middle of where the ischium and pubis meet, then erase what is inside of the hole. This is the obturator foramen.

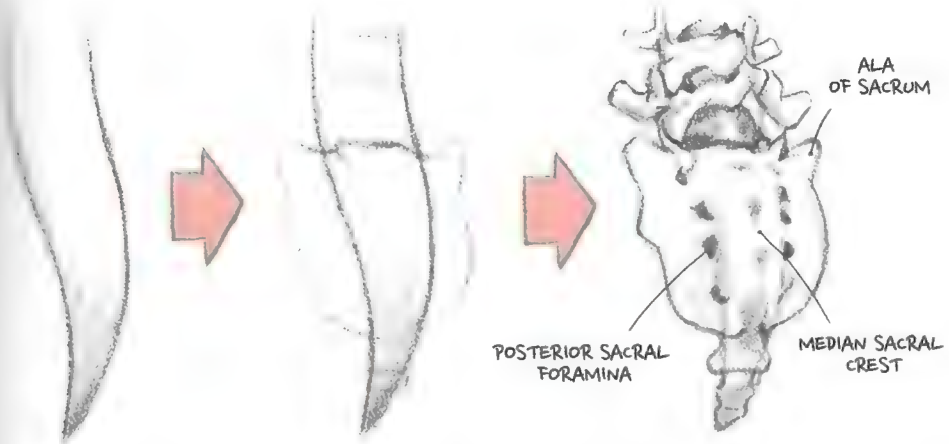
② Once we draw the 'acetabulum' where the head of femur is located and the 'ischial tuberosity' that sticks out behind and below the acetabulum, our drawing is complete.





Drawing the back of the pelvis

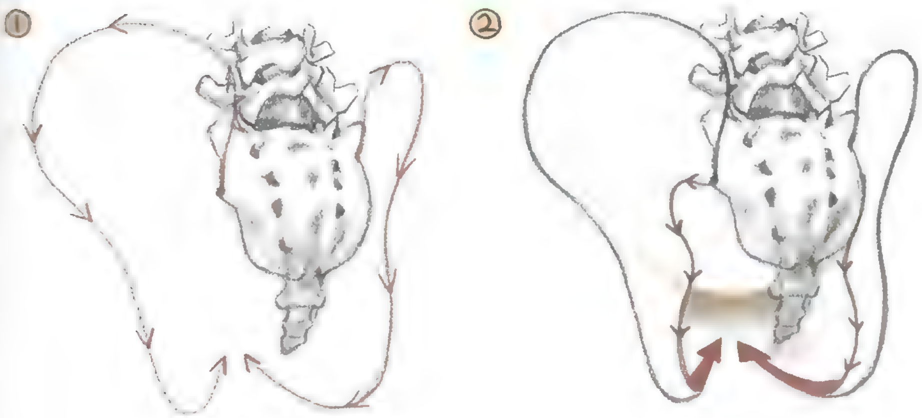
- Just as we drew the front of the pelvis, first roughly sketch the coccyx at the end of the lumbar vertebrae to look like a slightly bent brush tip. Then, divide it into three parts and draw the lumbar vertebrae, sacrum, and coccyx in the respective order.



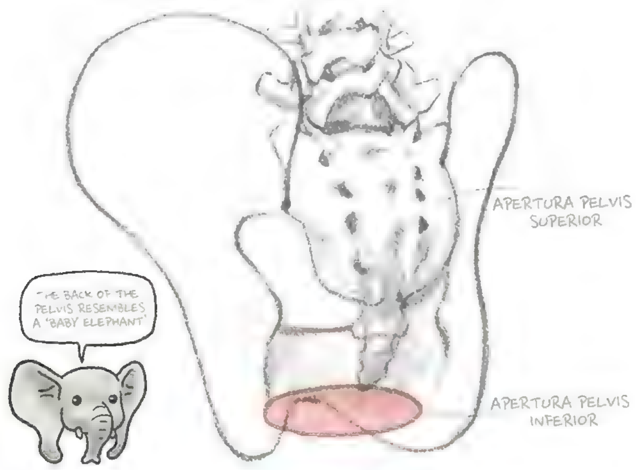
- We will now draw the hip bone.

  ① First, draw the outer outline of the hip bone.

  ② Next, draw the 'ischial spine' that projects and the gentle curve of the bottom of the 'ischium.' Remember that the ischium turns into the pubis as it heads towards the 'pubic symphysis.'



You are now almost done.
While the front side of the pelvis resembles hands gathered together to scoop up water, the back side of the pelvis resembles a baby elephant. Since we are drawing the back of the pelvis, also take note of the apertura pelvis inferior at the bottom of the pelvis.



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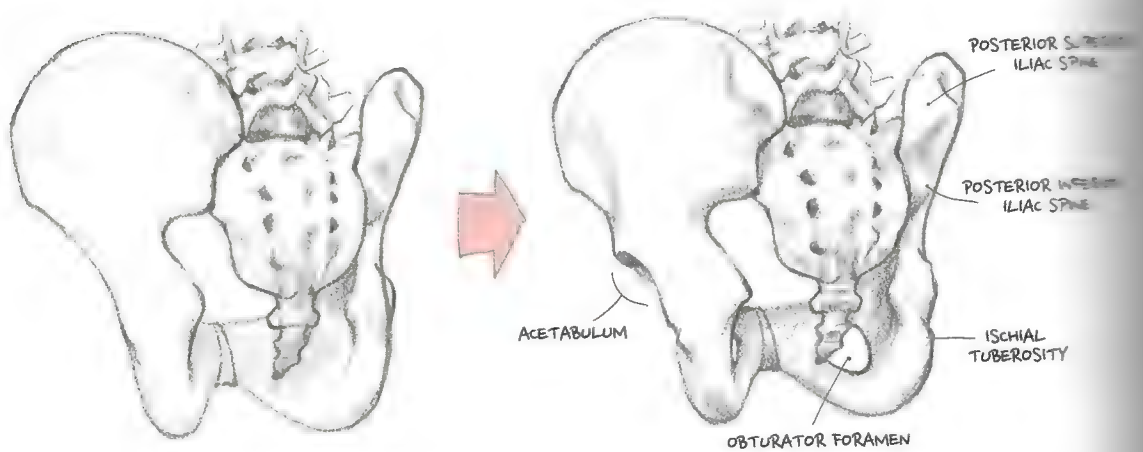
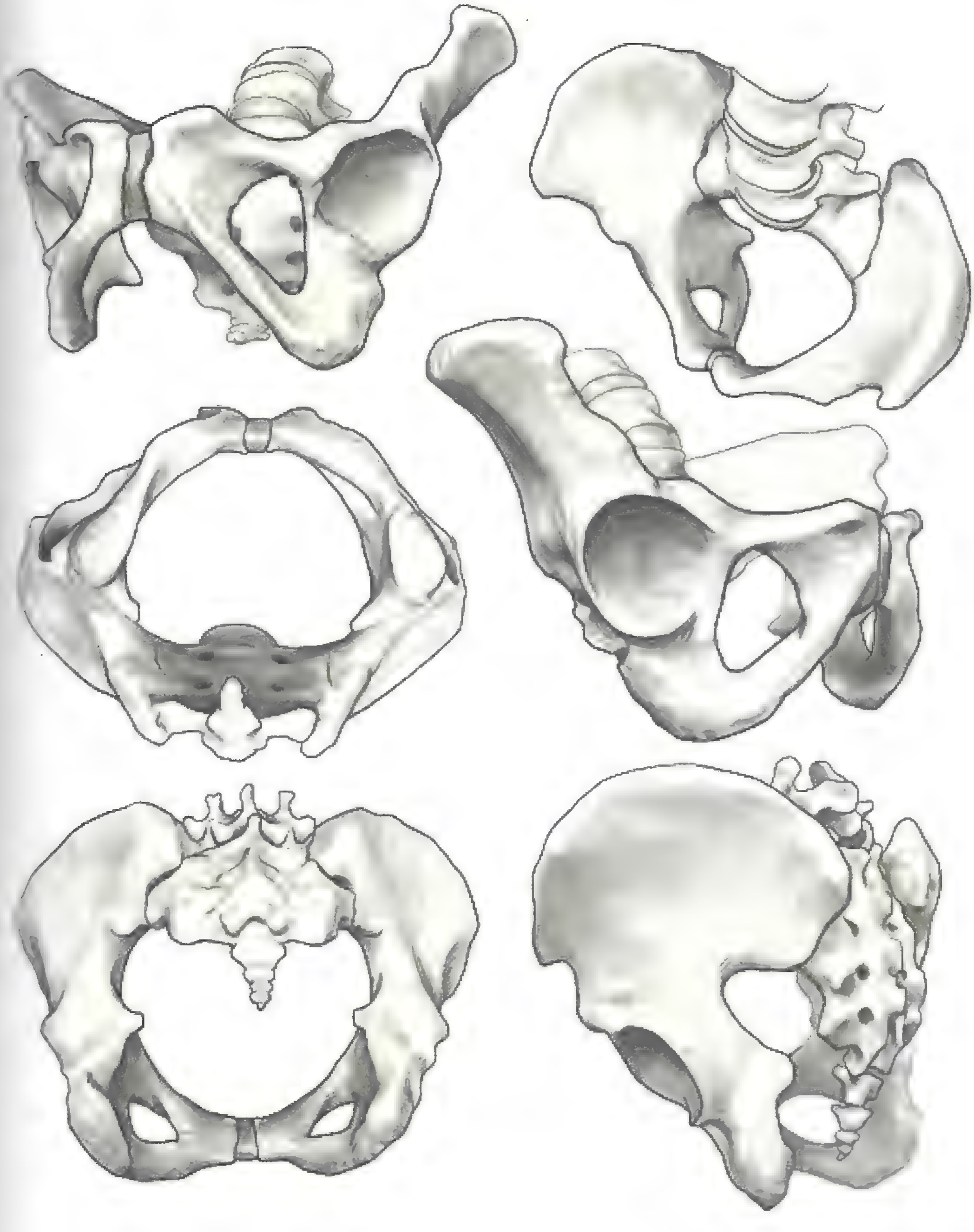
03. This is the last step. Now that we have the overall frame, you just need to add the detailed projections and depressions.



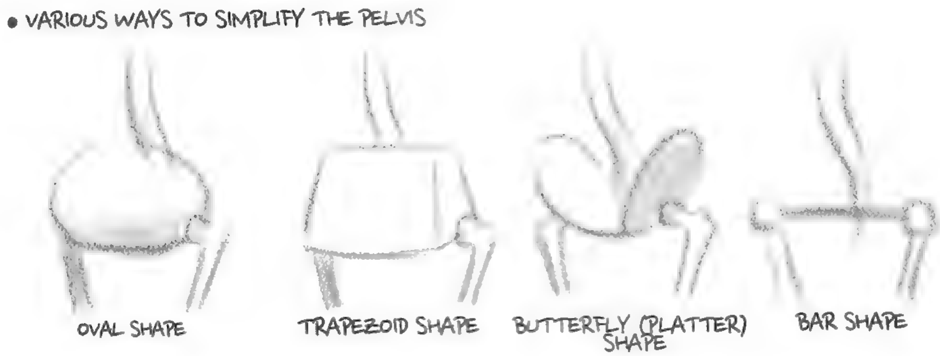
The Many Shapes of the Pelvis

tly, we will take a look at the various shapes of the pelvis seen from different angles. Take time ook at the parts you might not have understood before.

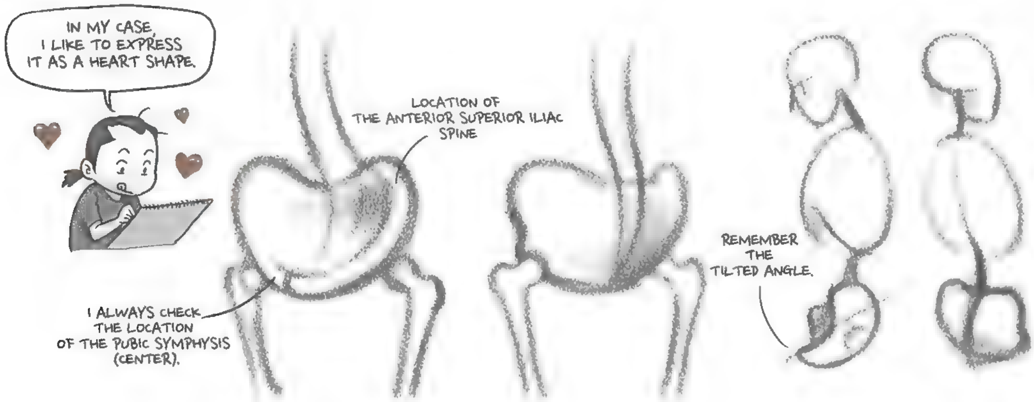


■Simplified Drawing of the Pelvis

Until now, we have drawn the pelvis in detail. Of course, we don't need to draw it in such detail when drawing the body. It suffices to show how the pelvis is situated in the body. That is why artists simplify the pelvis as shown below.



As you can see, there are many ways to express the pelvis. Each of these depictions have their pros and cons. Depending on how you see and interpret the 'pelvis,' a complex and dimensional structure, there can be many different ways to simplify it.



In my case, I like to draw the pelvis as a heart shape. For me the most important characteristics are the pelvis size in relation to the thoracic skeleton, the pubic symphysis that is the center of the pelvis, and the location of the anterior superior iliac spine that is a strong feature of the pelvis. These points are important to remember because the pelvis is not a structure fixed in one position.

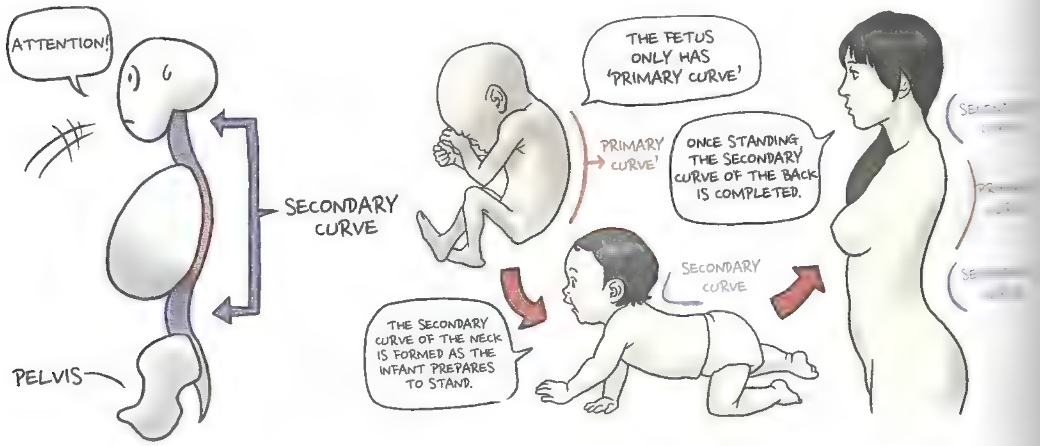
To summarize, 'simplification' is not a 'quick-and-easy' secret that I pass on to you, but a 'skill' that summarizes the basic drawing, so you can create your own simplified version. You don't need to take a separate lesson to learn how to draw a simplified pelvis. Regardless of how you choose to simplify, what is important is that you have a good understanding of the 'basic shape

Nude Study / painter9.0/2014

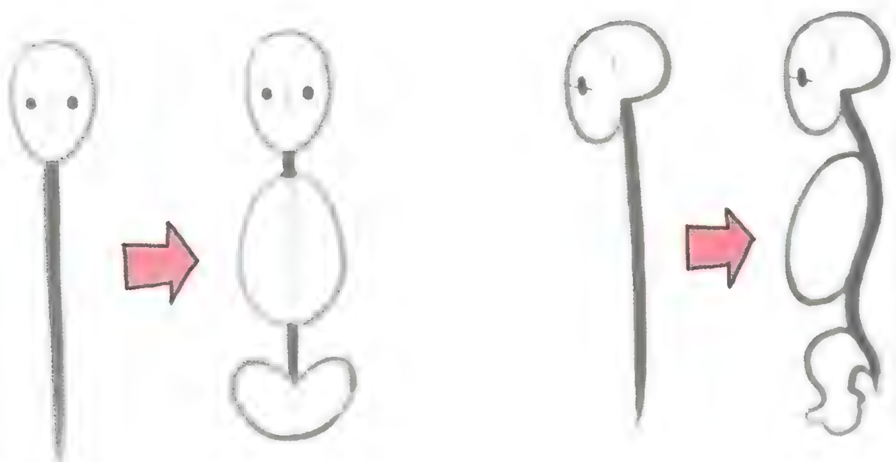
The Back Curves

So far, we took a look at the structures hanging on the vertebral column—the thoracic skeleton and the pelvis. We will lastly take a look at the vertebral column that holds them. As you know, this book is about the 'form' of the human body.

The thoracic skeleton is not a straight line, but slightly bent at the back. This bend helps to hold the oval-shaped thoracic skeleton over a wider surface. This is called the primary curve. There is also a secondary curve that holds the pelvis and hanging legs, and that accommodates the erect human characteristic. The curves serve as springs that mitigate the weight of gravity received by the vertebral column as it supports the heavy head and chest.



A simplified version of the vertebral column holding the chest and pelvis would look like the drawing below. As you can see, the primary and secondary curves are clearly visible from the side view rather than from the front.



Wait! Position of the vertebral column

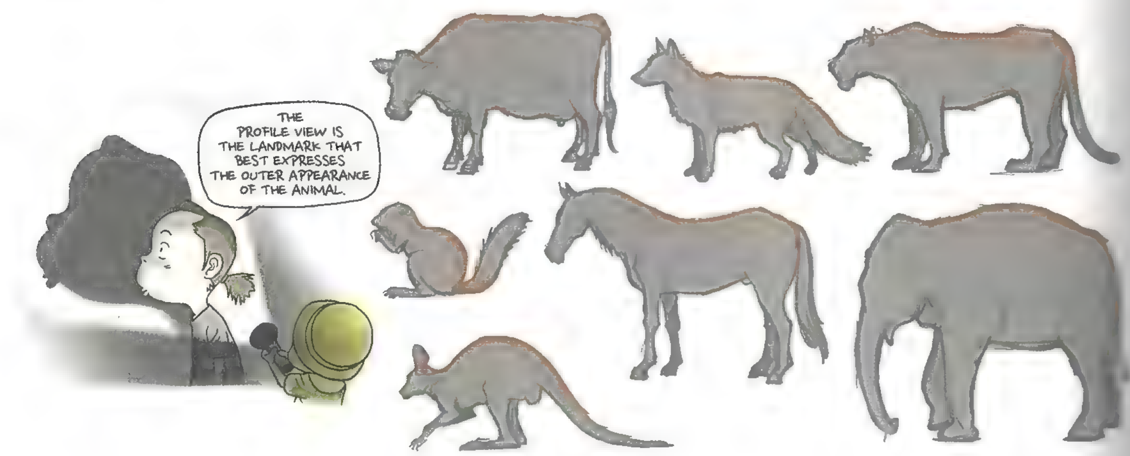
There is an interesting story about the vertebral column.
Artwork from BC to Renaissance period tends to emphasize the 'secondary curve' of men and the 'primary curve' of women. This emphasis on the 'secondary curve' of men is called the 'lordotic pose' while the 'primary curve' emphasis for women is called the 'kyphotic pose.'

Major examples of the 'lordotic pose' and 'kyphotic pose:' Bacchus by Michelangelo / Venus de Milo

The term 'lordotic' derives from the word 'lordosis' that refers to a vertebral curve that arches too far inward. 'Kyphotic' comes from the word 'kyphosis' that refers to a thoracic spine that has an excessive outward curve. 'Lordosis' has an effect of pushing forward the pubis (even more than the natural angle of the male pelvis). In the case of women, it is said that traditionally many women had to work in a hunched over and crouching position (cooking and child-rearing), which led to many 'kyphosis' patients. That is how 'kyphotic' became the representative pose of women (Reference: Our body and Art by Cho Yong-jin).

Some of you might have noticed that this explanation goes against the natural angle of the male and female pelvis (refer to page 190). Since physical beauty is easier to express by emphasizing the natural landmarks of the male and female body, it would actually make more sense for men to be kyphotic while women are lordotic. The 'lordotic' male and 'kyphotic' female poses were postural deformities developed due to the lifestyle and habits of the era, so we cannot necessarily say that they are 'natural landmarks.' These poses were artistic methods used by the artists of the time to maximize the aesthetic beauty of the male and female figure.

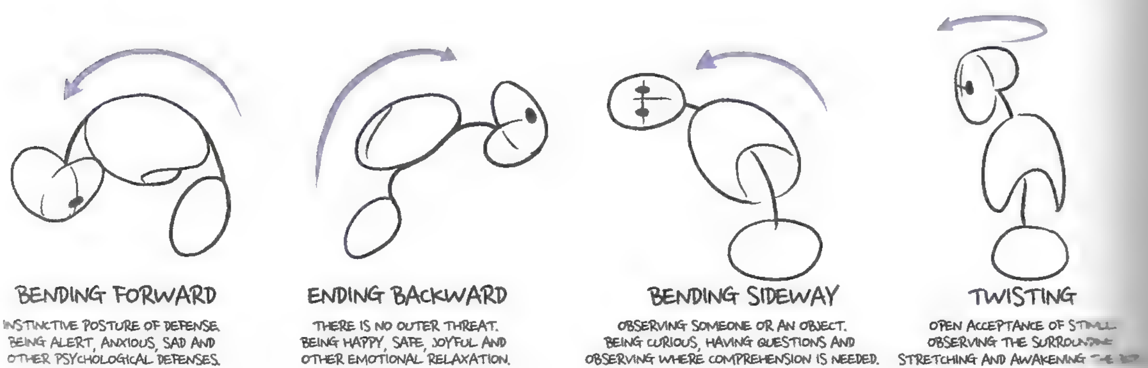
The physical characteristics of most vertebrate animals, including humans, are most highlighted when the vertebral column is seen from the 'side' and not from the 'front.' In particular, the vertebral column of four-legged animals forms the spinal ridge that reflects the environment and the animals' movement. The spinal ridge can be said to represent the animals' outer appearance.



We can guess the animal by looking at the silhouette of the spinal ridge formed by the vertebra. However, in the case of humans, we communicate by looking at each other in the face, so we are more accustomed to the front view.

■Movement of the Vertebral Column

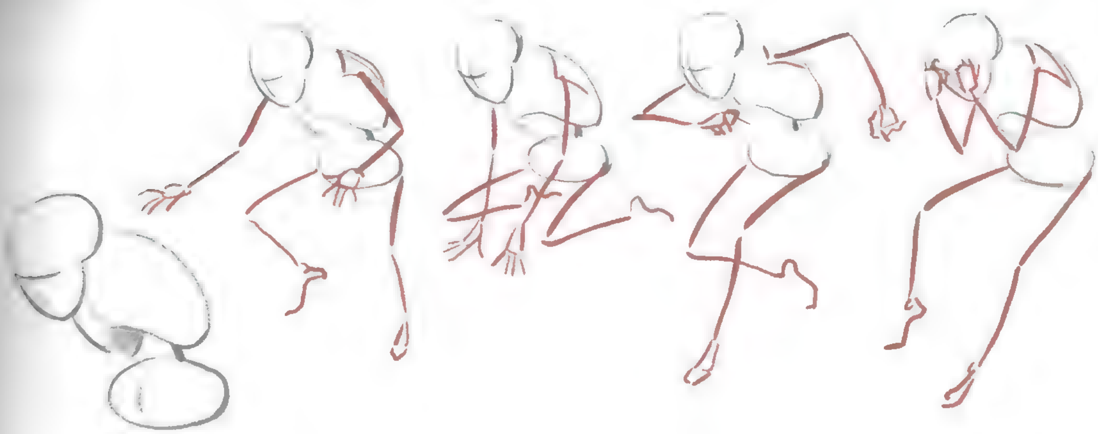
The vertebral column holds the chest and pelvis. Just by using the body trunk surrounding the vertebra, it is possible to express emotions. It becomes the basis for 'motion,' or the body's big movements.



Motions and the corresponding emotional symbols. Bending forward is an instinctive movement to protect vulnerable organs in front of the body; bending backward is the opposite of that bending sideways shows intent to observe something from a different angle.

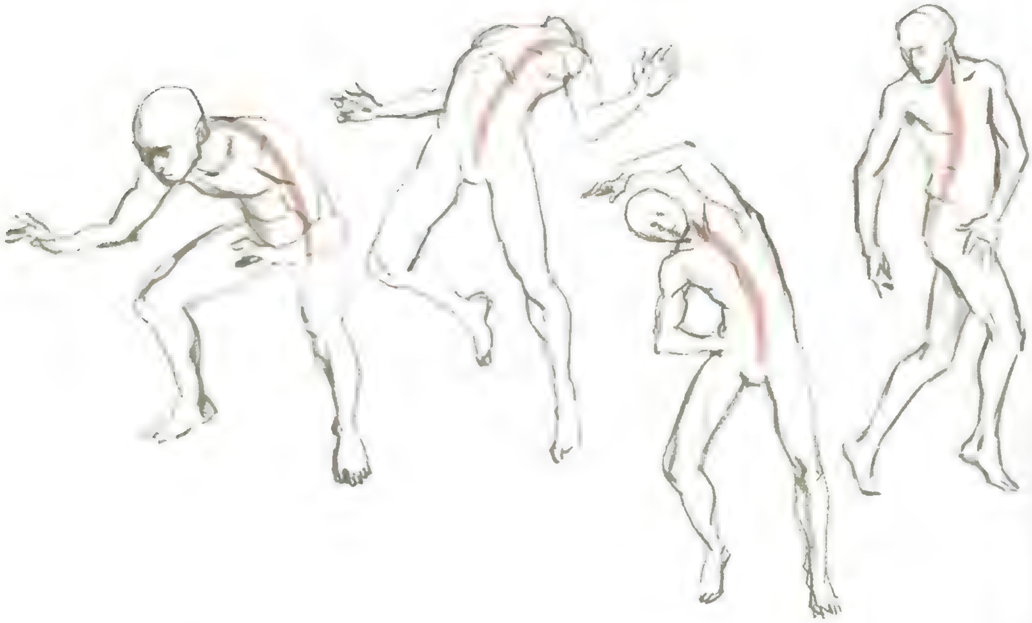
ement is the sensation of motion in a picture or sculpture is a very important concept used to ess a motion of a person or object on a stationary screen. It is also very important to remind elves that this sense of motion comes absolutely from the 'body.'

arms and legs may seem more spectacular and complicated at first glance. In the end, ever, arms and legs are only there to balance and support the large movements of the e or merely to serve as a supplement stabilizer. For that reason, if you grasp the state of spine first in any movement, it is a piece of cake to express the rest of the components like s and legs.



A FUNDAMENTAL FORM

(Picture: Various poses derived from the fundamental form (a forward bend) of spinal motion. We can create zillions of poses aside from these. Without further ado, let's draw it!)

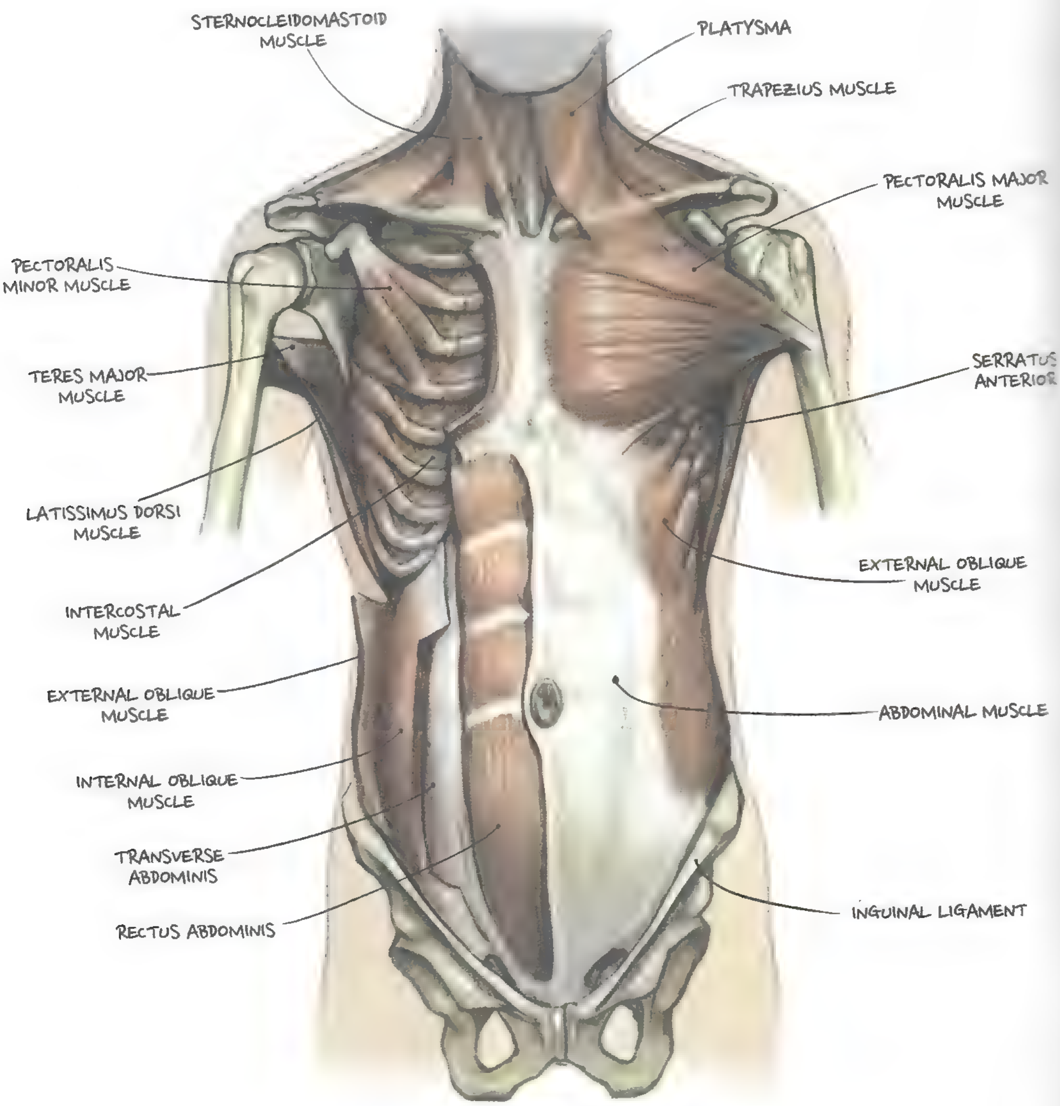


(Picture above (from left): The forward, backward, lateral, twisting motion of the spine / Photo below: Author's study in nude croquis. Please pay attention to the 'movement' derived from the spinal movement.

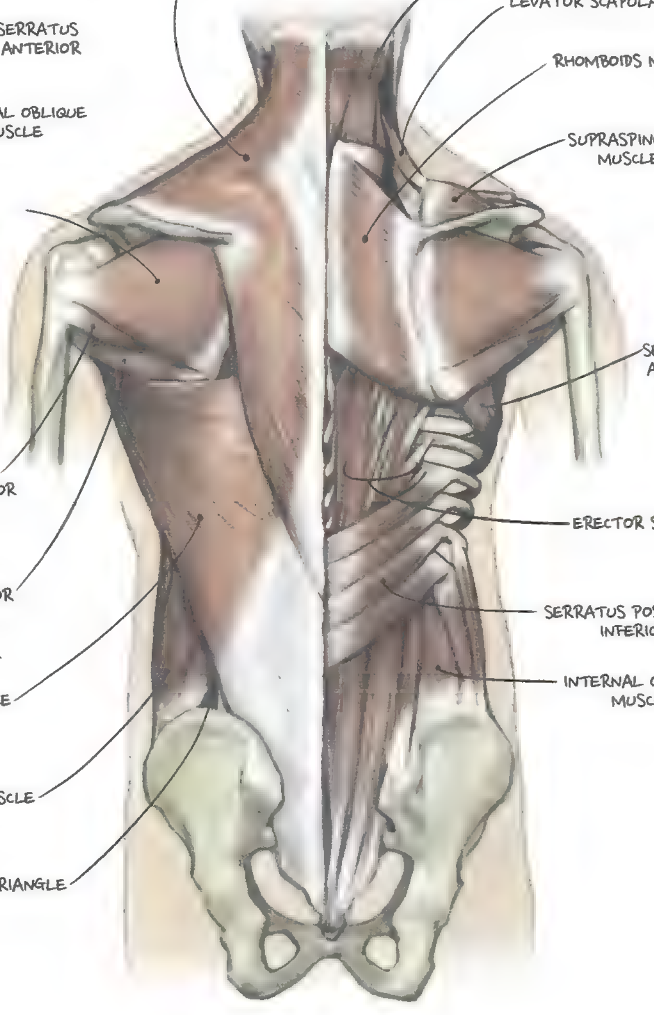
Muscles of the Body

The Muscles of the Entire Torso

It is now time to learn about different muscles of the body attached to our spinal cord, thorac[illegible] cage and pelvis. Compared to the other muscles, the muscles on the torso are large in size a[illegible] volume and thus there are only a few of them. We'll go through them quickly and move on to [illegible] next chapter.

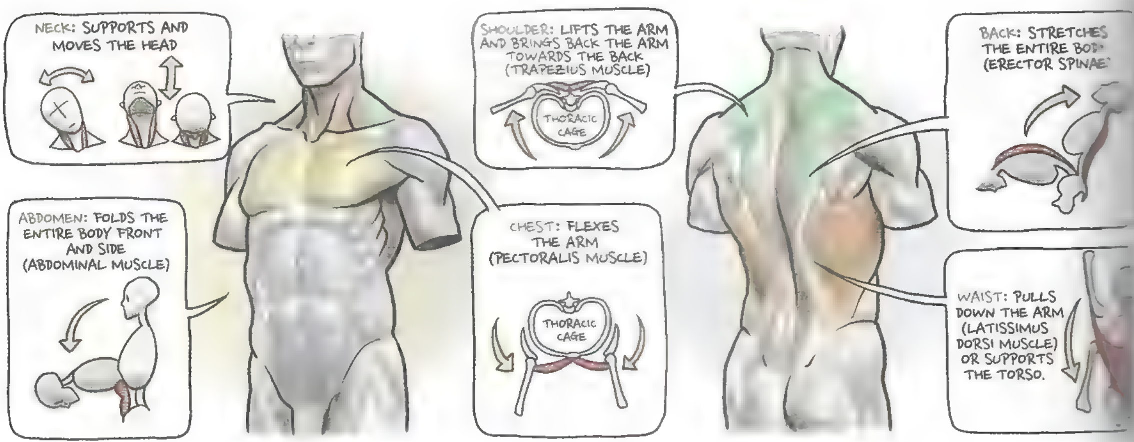



TRAPEZIUS MUSCLE
SUPRASPINOUS MUSCLE
INFRASPINATUS MUSCLE
TERES MINOR MUSCLE
TERES MAJOR MUSCLE
LATISSIMUS DORSI MUSCLE
SERRATUS ANTERIOR
EXTERNAL OBLIQUE MUSCLE


TRAPEZIUS MUSCLE
SPLENIUS CAPITIS
LEVATOR SCAPULAE
RHOMBOIDS MUSCLE
SUPRASPINOUS MUSCLE
SERRATUS ANTERIOR
TERES MINOR MUSCLE
ERECTOR SPINAE
TERES MAJOR MUSCLE
SERRATUS POSTERIOR INFERIOR
LATISSIMUS DORSI MUSCLE
INTERNAL OBLIQUE MUSCLE
EXTERNAL OBLIQUE MUSCLE
LUMBAR TRIANGLE

■Classification of Body Muscles

You can think of the torso,'as we call it, as a part that contains structures (thoracic cage and pelvis) that are usually directly connected to the spinal cord. From the bottom of your head to the top of your pelvis, you can break the front torso into three parts – the neck, the chest and the belly. The back, which helps stretch the entire body, has the erector spinae muscles that penetrate the entire back torso, so it is better to study the back torso totally separate from the front torso.

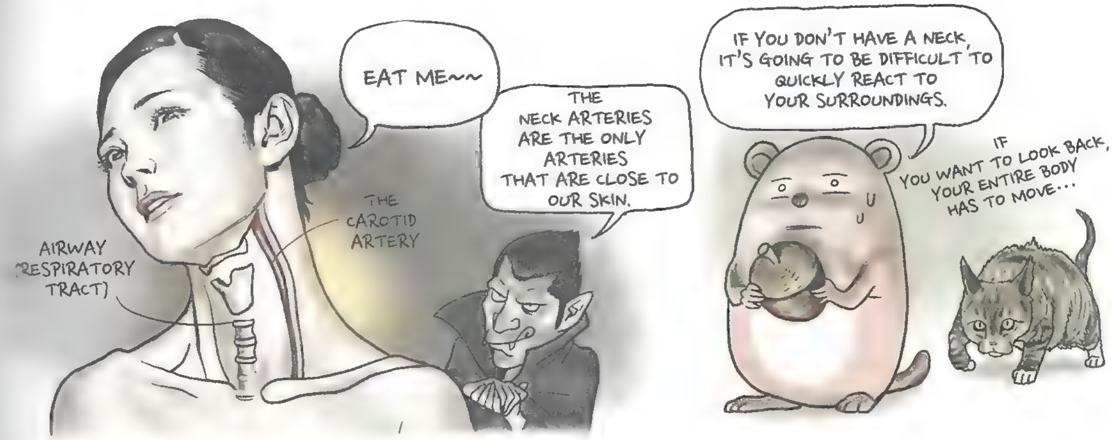


Since the torso takes up the largest area of our body, you may think that the torso muscles are complex and intricate. However, contrary to what we may think, it is relatively simple. The torso requires the most energy and strength, the muscles are big and relatively simple. Just like the drawing above, if your grasp the role of different parts first, it is relatively easier to understand. Let's take a look at the 'neck' first.

Muscles of the Neck

■The Long Neck

Normally, the 'neck' is thought of as a gate or bridge that simply connects the head and chest. But if you think closely, our neck not only passes the oxygen we breathe into the lungs, it also supplies fresh blood from the heart to the brain through the neck arteries (the carotid). Due to its important role, we can say that our neck is directly linked to our life, but then why is our neck so exposed?



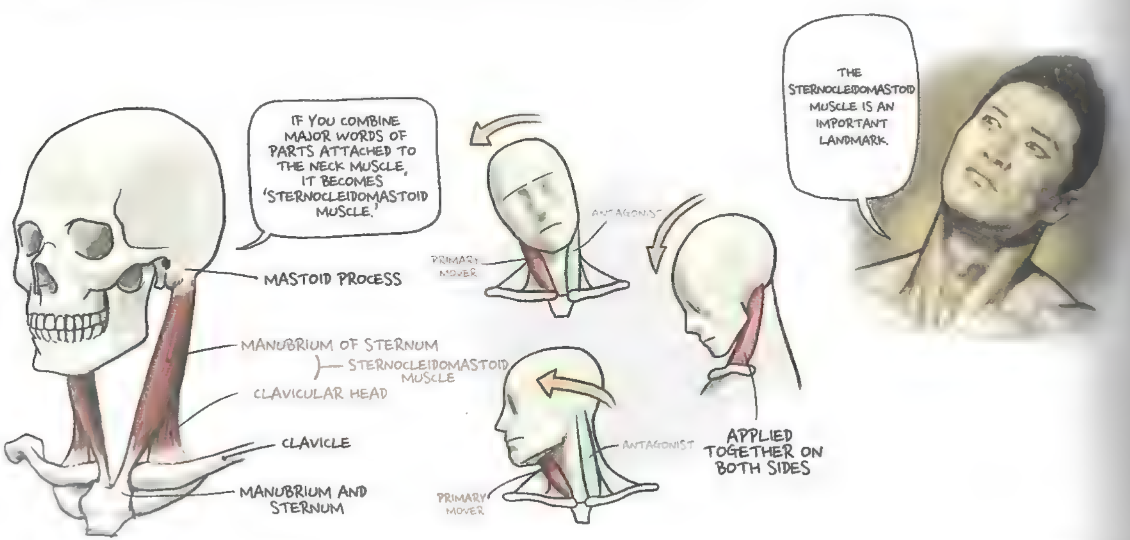
In other words, whether it is to reach preys on the trees or to quickly discover distant predators, securing a wide range of sight is more helpful in survival than merely hiding the neck. For humans, the ability to stand and use the hands evolved us to have shorter necks.

But our need to physically move our heads is same as for other animals.

Due to the important neck being exposed to outside dangers, when a person feels threatened or exposed to cold, they naturally contract the neck muscles to duck one's head. Although, our neck muscles play a role in moving our head. It also protects the arteries and the airway. I guess our neck is in charge of protecting our lives.

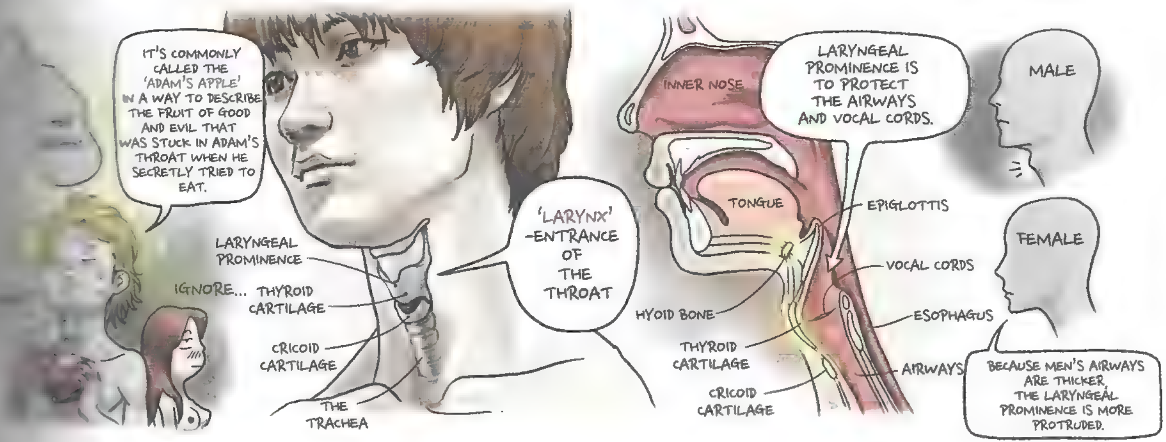
■Major Muscles of the Neck

There are different muscles that protect the carotid arteries and allow the head to move in diffe directions but the role of the neck's major muscle, the sternocleidomastoid muscle, is the most important. Regardless of gender, the sternocleidomastoid muscle is the main indicator needed to visually describe the neck. Moreover, it is the major exemplification of a 'primary mover' and 'antagonist' mentioned earlier in the outline of the muscles.

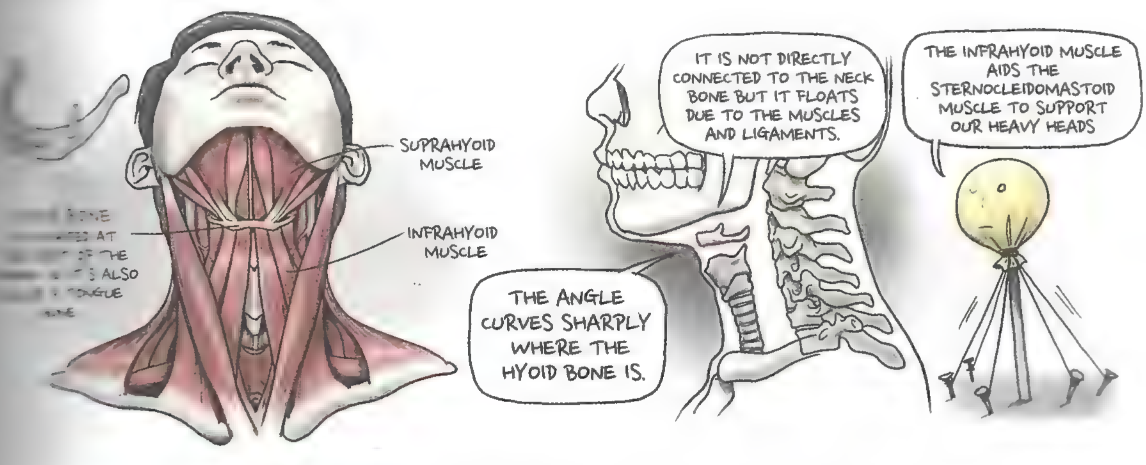


ease note that movements such as tilting or turning the neck sideways is a complex movement that involves many muscles around the neck, including scalene muscle and trapezius muscle.

...een both sternocleidomastoid muscles, there is a 'laryngeal prominence' commonly ... as the 'Adam's apple.' Laryngeal prominence is the lump that is formed by the angle ... 'thyroid cartilage' (the thyroid) surrounding the larynx. It helps protect the inner airways ...ell as the vocal cords. Because the vocal cords are bigger in men than in women, men's ...oid cartilage is relatively more protruded than that of women's. That's why the 'Adam's apple ... considered a symbol of masculinity.



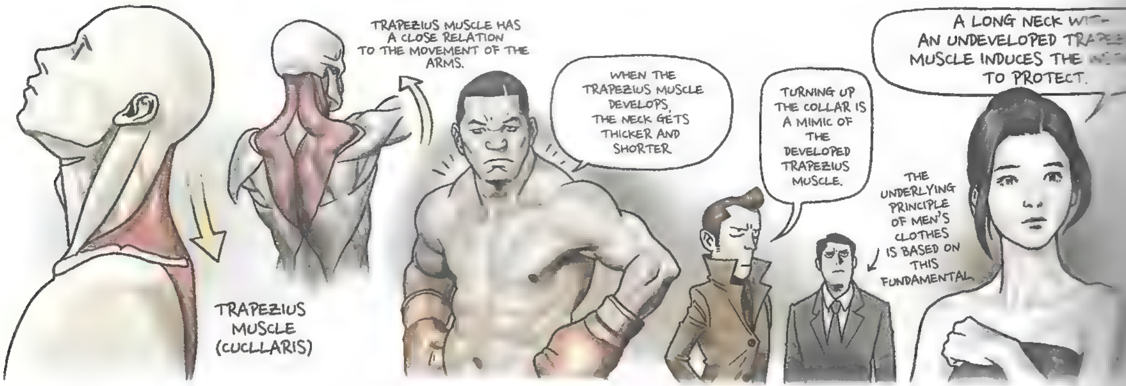
...hyoid bone (tongue bone) is situated on top of the thyroid cartilage to make an angle inside ...eck. The muscles from the upper hyoid pull the chin inwards in order to aid in opening the ... and chewing foods. The hyoid bone provides attachment to the muscles. Towards the ...om, the hyoid aids the sternocleidomastoid muscles to move and support the neck.



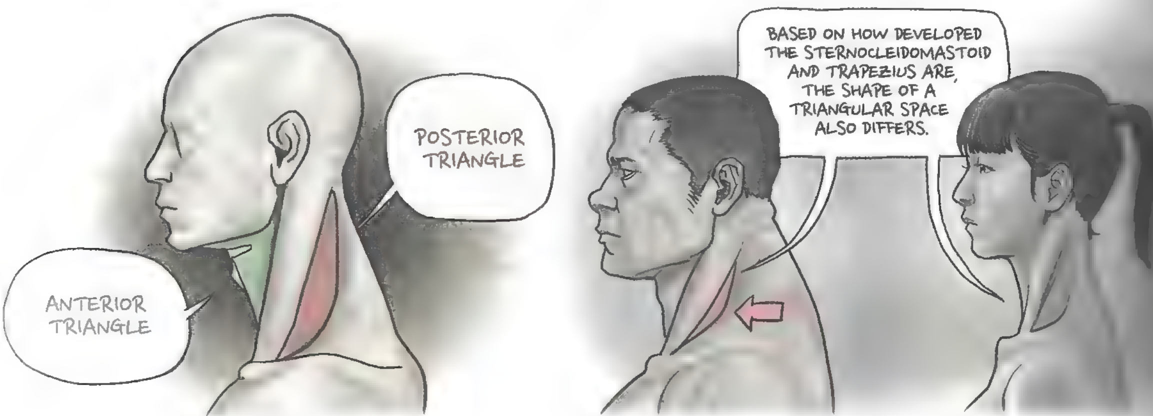
[Chewing, swallowing, and talking are other functions of the neck's inner muscles.]

The collarbone and shoulder blade to support our arms and shoulders, and therefore play a crucial role in moving the arms. We will study the trapezius muscle again when we learn about back muscles in page 258.

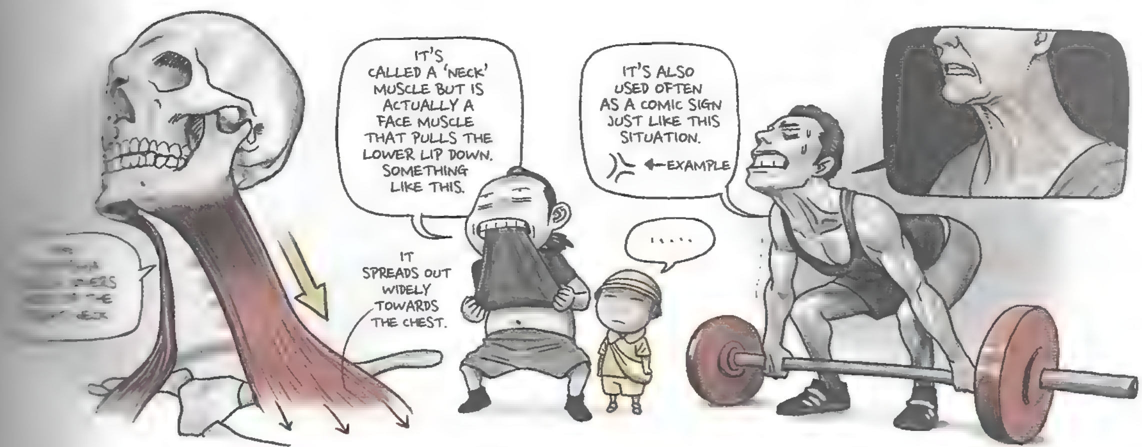
Because the trapezius muscle covers both the neck and the arms, using our arms often cause the trapezius muscle to develop and for the neck surrounded by this muscle to look thicker. Th is why thicker necks end up symbolizing strength and power.



The sternocleidomastoid muscle and the trapezius muscle are major muscles in the neck. Fr the side they create a triangular space below the neck and in between the sternocleidomast muscle and trapezius muscle. The triangular space in front of this muscle is called the ante triangle and the space behind it is called the posterior triangle. In terms of art anatomy, these spaces are a very important indicator when representing a person.



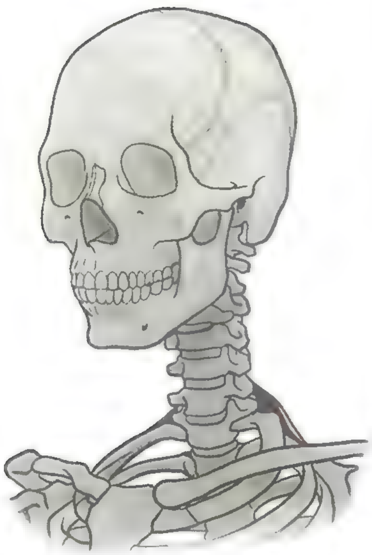
the platysma muscle that starts at the end of the chin and spreads out towards the ... and wraps around the neck. However, it is more of a mimic muscle belonging to the face than ... neck muscle because it touches the skin. The platysma muscle is often used to describe ... where someone is lifting something heavy because the tendon in your neck vividly shows ... you lift your chin up. It is often observed in the necks of elderly people.



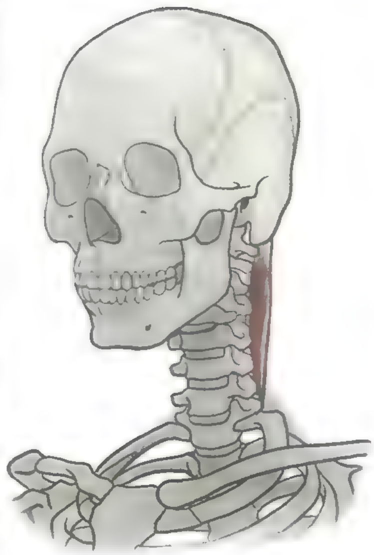
Because the 'external jugular vein' is placed outside of the platysma (refer to pg. 623), it tends to protrude out more when the neck is flexed.

Attaching the Neck Muscles

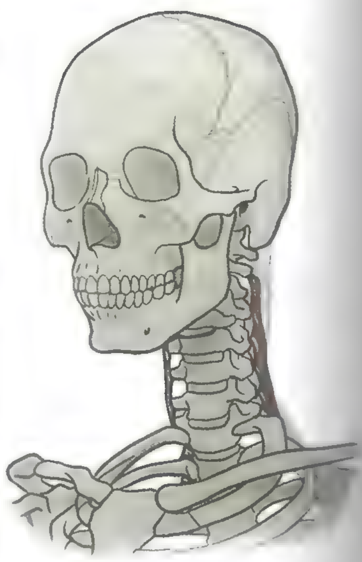
...th the face, let's try to attach different layers of the muscle one by one. To be honest, ...cluding the major neck muscles introduced in earlier page, there are many small and thin ...scles just like an electric wiring and thus it is very difficult to grasp every detail. Those ...es are covered by the major muscles such as the sternocleidomastoid and trapezius. That ...ing said, I recommend you know the role and function of those muscles as a reference only.



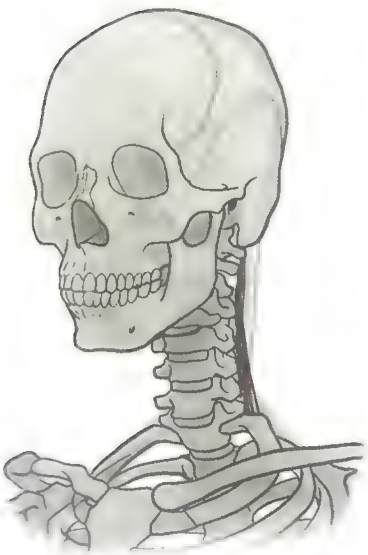
01. serratus posterior superior muscle



02. capitis muscle



03. longissimus cervicis mus…



04.semispinalis capitis muscle

05. digastric muscle, splenius cervicis muscle

06. iliocostal muscle of thorax, longus colli m…

07. scalenus posterior muscle

08. levator scapulae muscle

09. scalenus medius muscle

10. scalenus anterior muscle

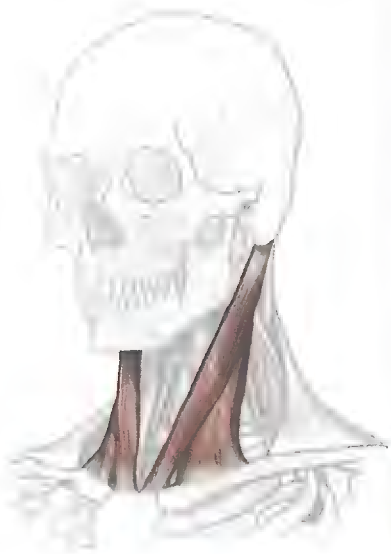
11. hyoid, thyroid cartilage

12. sternothyroid muscle

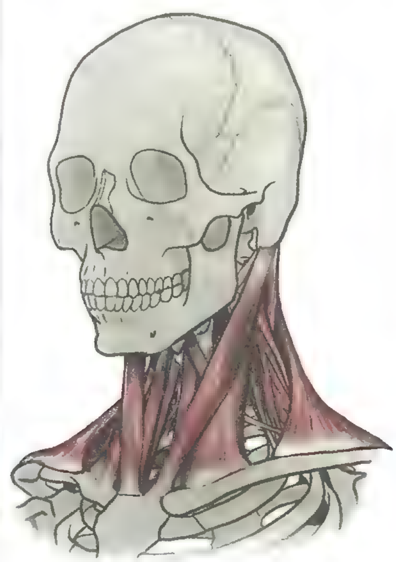
13. sternohyoid muscle

14. omohyoid muscle

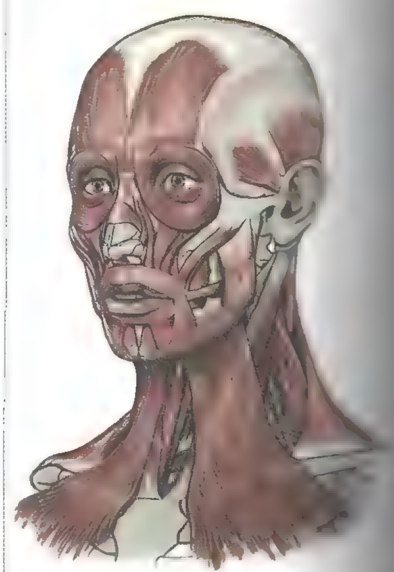
15. trapezius muscle



16. Sternocleidomastoideus muscle



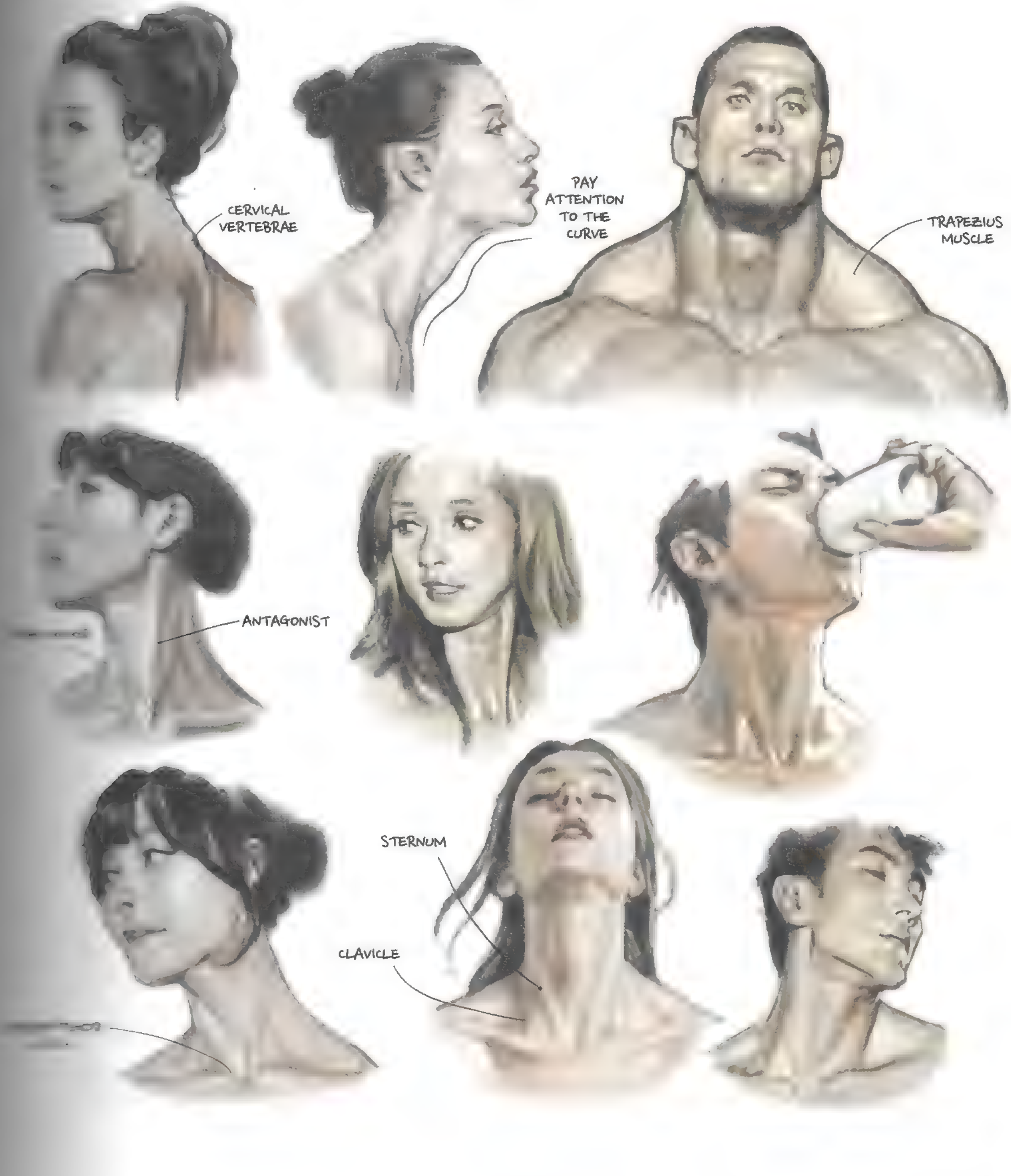
17. Ossa hyoideum
Neck muscles viewed from the front



18. platysma, Face musc[illegible] neck muscles includ[illegible]
(for face muscles, please r[illegible] page 121)

...ferent Models of the Neck

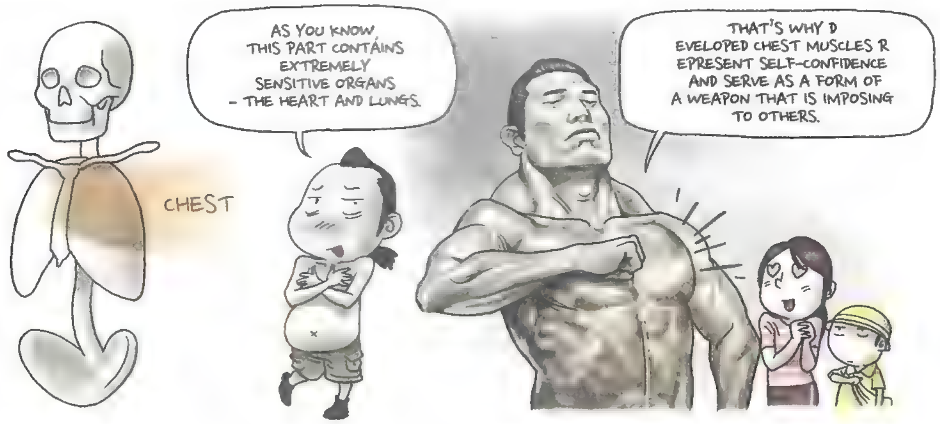
...ok at the neck from the outside, only a few important indicators are visible; the ...eidomastoid muscle, *platysma muscle, laryngeal prominence, and the clavicle.* ...e the remaining are hardly visible. How well you depict those important indicators is the ... in presenting the neck. Let's try to review the names of different parts we studied earlier.



Chest Muscles (Pectoral Muscles)

■Embracing the Chest

The chest is located between the clavicle and the abdominal (usually rib five). We also call the chest muscle 'pecs.' Because the chest is closely related to the movement of the arm, it is a symbol of masculinity. Moreover, as the pectoral muscle fans across the chest from the shoulder to the breastbone, it provides primary protection for our major vital organs such as the heart and lungs.



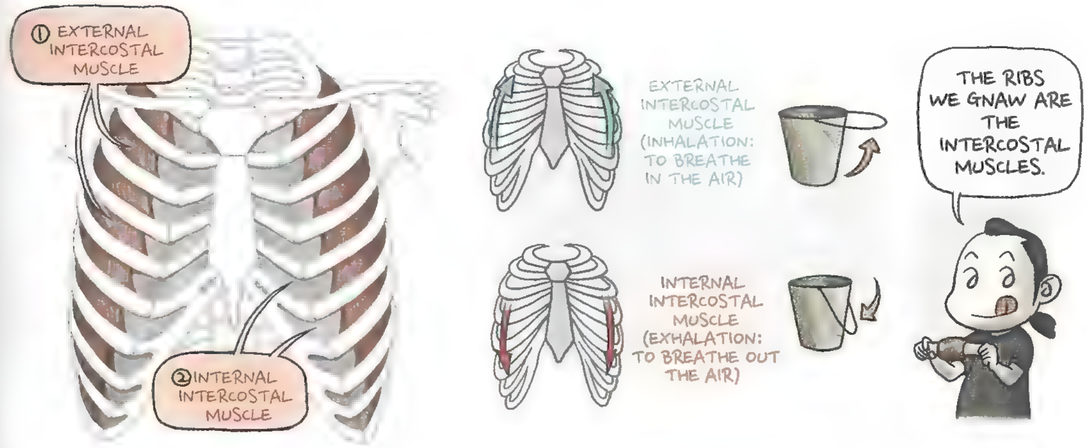
Koreans also refer to the chest muscle as 'gapbba.' It is a colloquial term derived from Japan which is a Japanese pronunciation of a Portuguese word. The word used to mean 'raincoat, a shelter tent,' but it is now used to define 'physique, reputation and muscularity.'

Pectoral muscles allow the thoracic cage to move up and down to help breathing. Their primary function is to flex the body forward and draw in the arms tightly. Because boxing and judo require movements where the arms are thrown towards the front, so they develop bigger chest muscles.

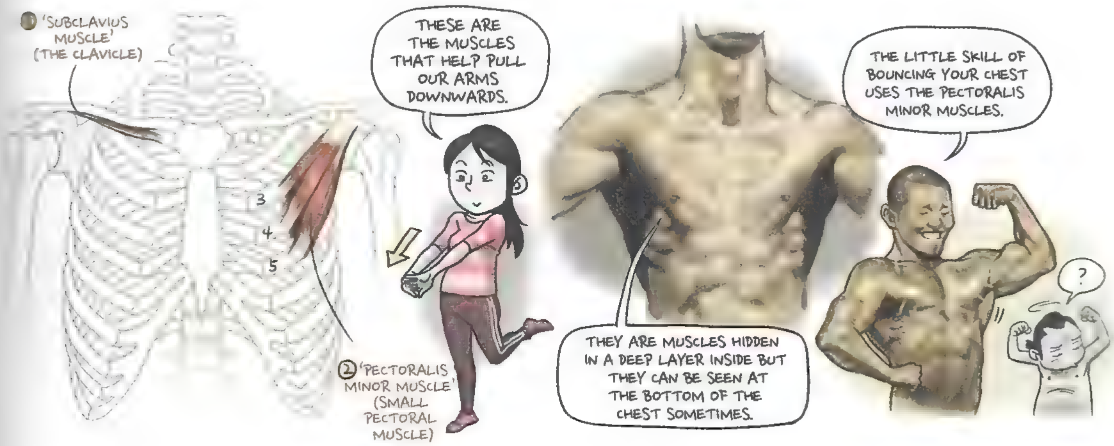
A bird's chest is large in size, but it doesn't taste too good. The constant flapping of wings leaves the bird's chest with no fat.

■Major Muscles of the Chest

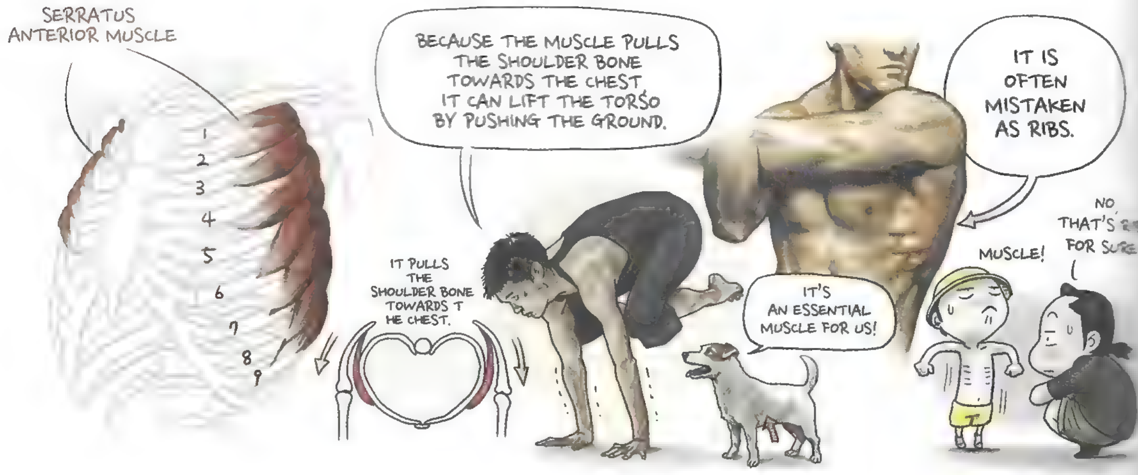
First off, let's take a glimpse at the intercostal muscle. It is not visible externally but is essential for breathing. Intercostal muscles run between the ribs and it is differentiated by the external intercostal muscles and internal intercostal muscles. Here's how the intercostal muscles move the ribs to facilitate breathing. This principle also appears later in the chapter when we discuss the back muscles, 'serratus posterior superior' and 'serratus posterior inferior,' so please make sure to remember this concept.



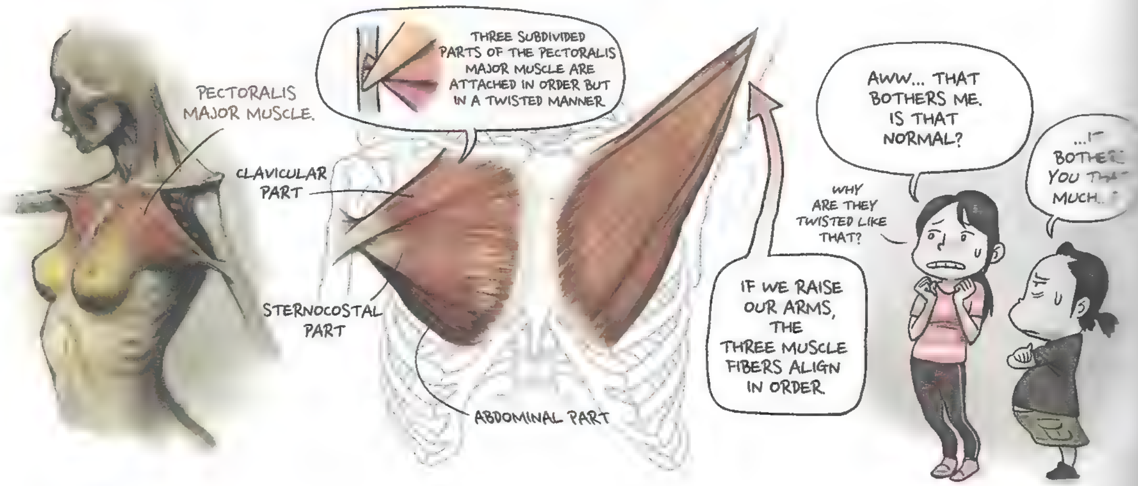
Let's now look at the muscles that move the arms. The subclavius muscle (the clavicle) and the pectoralis minor muscle (small pectoral muscle) are an important part of the 'coracoid process' of the clavicle and the shoulder bones respectively. They reach toward the ribs and pull the shoulder bones forward and bringing the entire arm together.



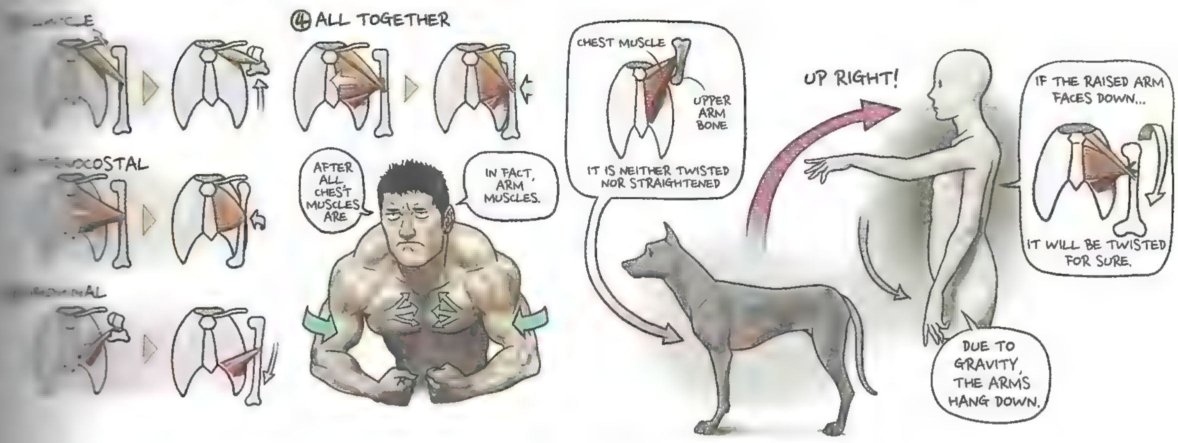
Now those two muscles by themselves could hardly support the many functions of our arms. That's where this muscle comes in. The serratus anterior muscle originates from the inner part of the shoulder bones and spreads out to the front of the thoracic cage. In Korean, it is named the 'sawtooth muscle' because of the way the muscle spreads to look like a sawtooth fish.



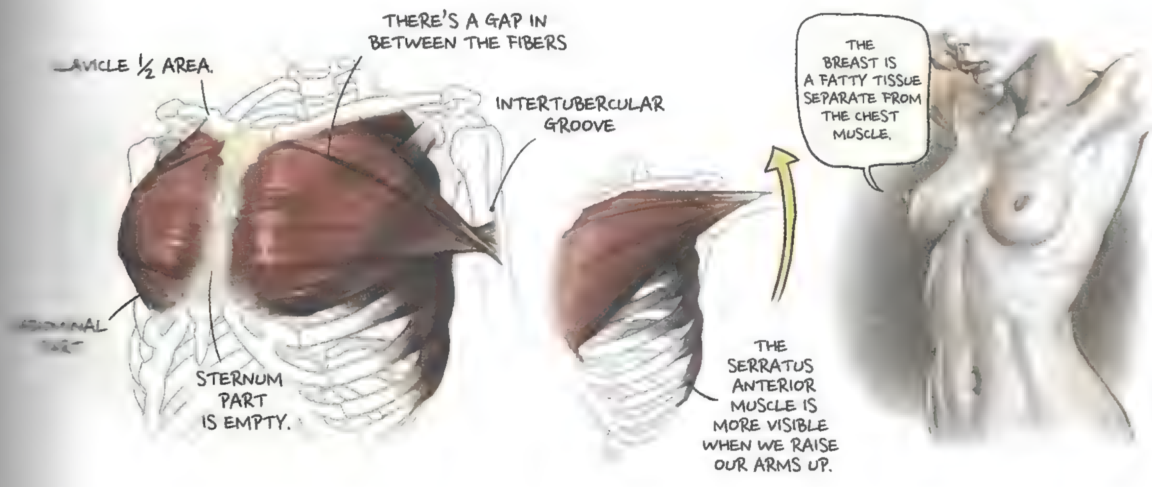
The pectoralis major muscle is the first thing that pops into our mind when we think of chest muscles. This muscle is not one mass, but is subdivided into three parts based on the tendon fiber's orientation: *clavicular, sternocostal and abdominal. The interesting part is that the point* of contact with the arm is opposite from where the chest starts, which tells us that it is 'twisted' Why is this the case?



The muscles are twisted in order to allow our arms to freely move up and down. For instance if the upper sternocostal part contracts, we can move our arms up and if the lower abdominal part contracts, we can put our arms down. It is difficult to determine if four-legged animals' pectoralis major muscles are twisted, as their front legs are always stretched towards the ground. However, in terms of humans, the muscles look more twisted when we raise our arms.

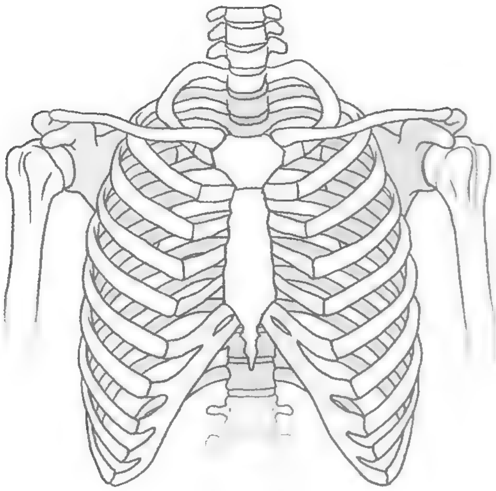


Since the pectoralis major is a large muscle among the chest muscles, it is considered the most powerful and is quite noticeable, as it is more developed. It can easily be observed in our daily lives and is symbolic in many ways, making it the muscle that is often highlighted when drawing characters.Therefore, it is very important to know the features of the pectoralis major muscle.



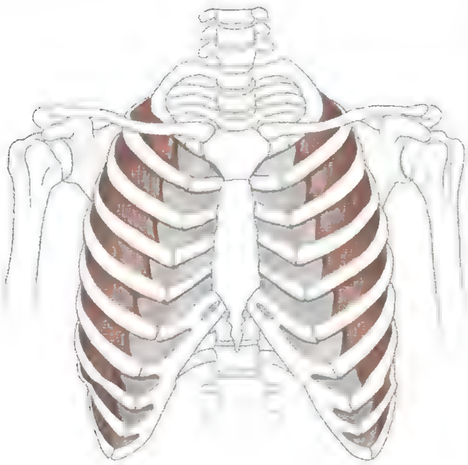
■Let's Try to Attach the Chest Muscles

Now, let's try to learn more about chest muscles by attaching the muscles one by one. Because muscles are usually attached in between many ribs it is important to pay attention to where it originates and touches.

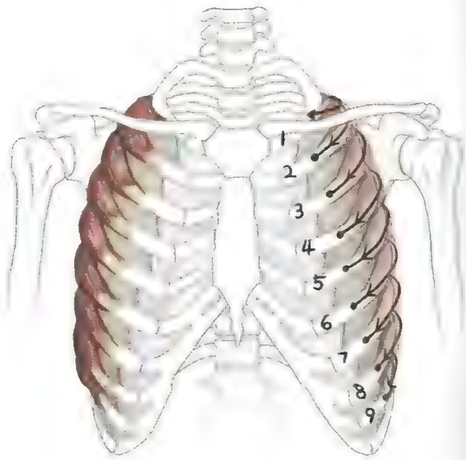


● Thoracic cage

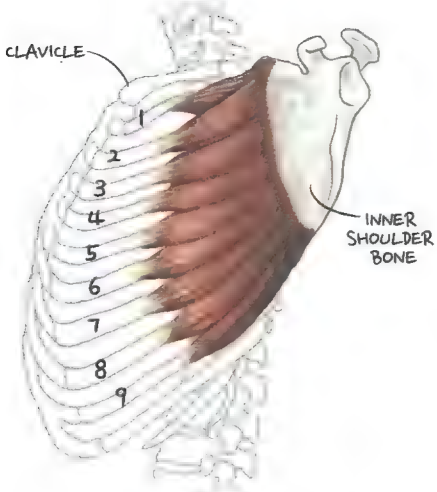
Skeleton that maintains the thoracic wall.



01. external/Internal intercostal muscle

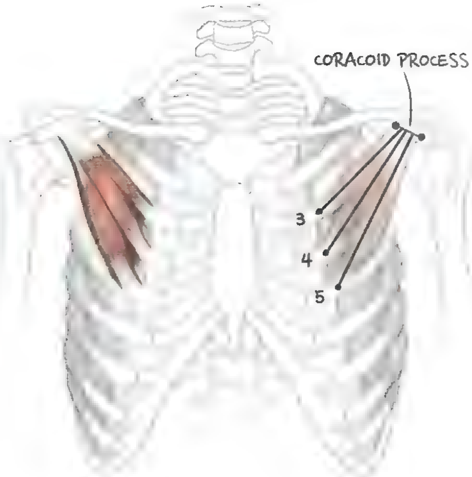


02. serratus anterior muscle



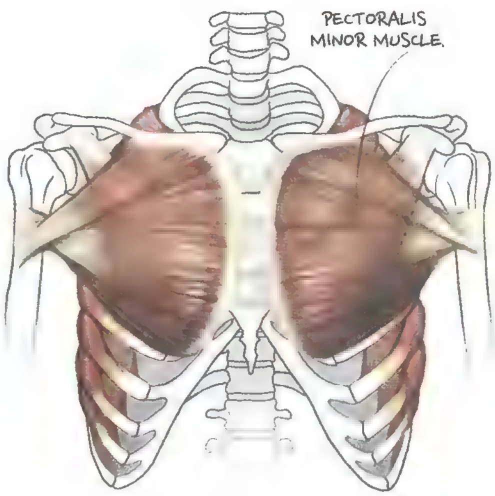
02-1.serratus anterior muscle

Serratus anterior muscle from the side.



03. pectoralis minor muscle

04. pectoralis major muscle



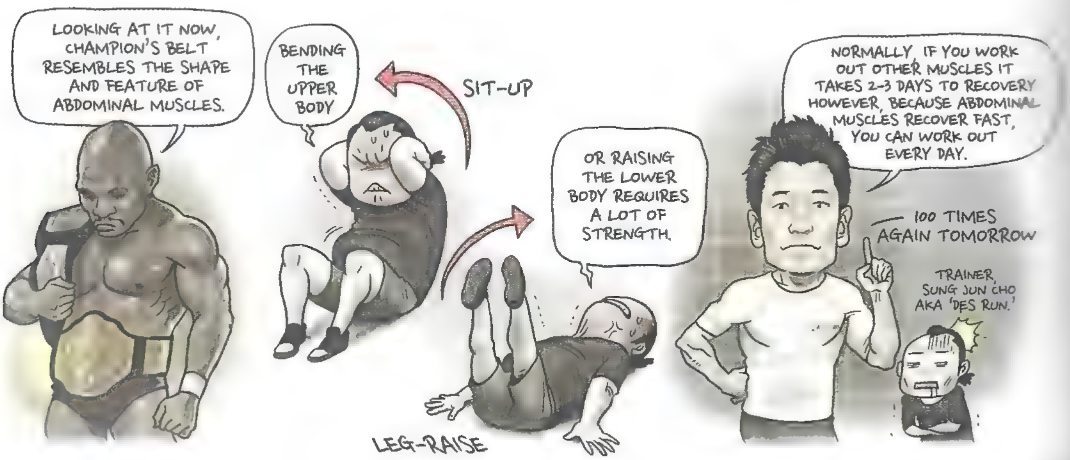
05. horacic muscles

Abdominal Muscle

■ Source of Abdominal Strength

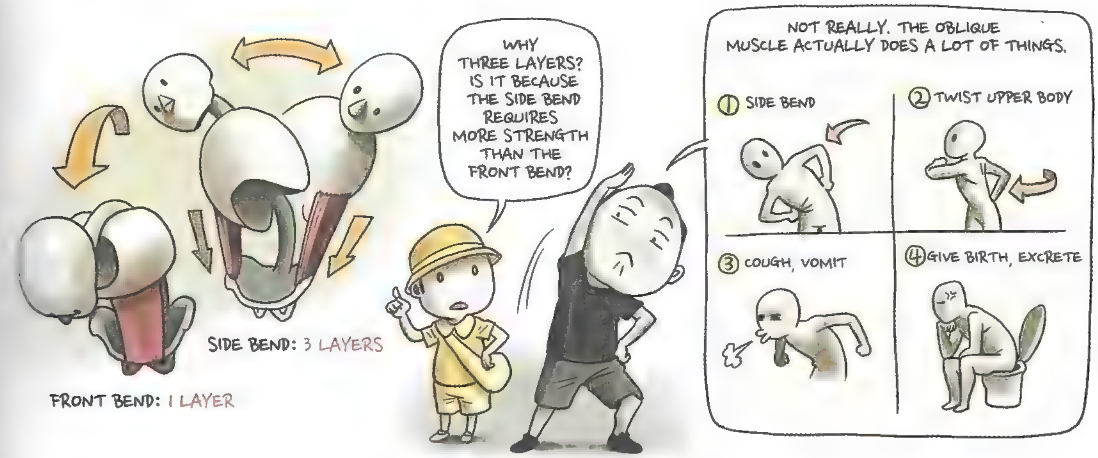
As we already know, the abdomen constitutes the part of the body between the thorax and pe
It is also located where all our digestive organs are situated. It has no bones aside from the vertebral column (lumbar vertebrae) in the back. which allows the abdomen to function as a la
joint which allows our upper body to fold, but the absence of bones to protect it makes it the
vulnerable part of the body. Therefore, it is a dangerous thing for vertebrates on land to show
abdomen to predators.

I have already mentioned these difficulties briefly (141p), but, the muscles used to aid 'moveme
also function as a 'defense barrier.' Even though this is not the case for everybody, the abdominal muscle is the strongest and toughest compared to other muscles in order to cont
both the heavy upper body and the lower body.
The abdominal muscle also needs fast recovery speed when damaged.

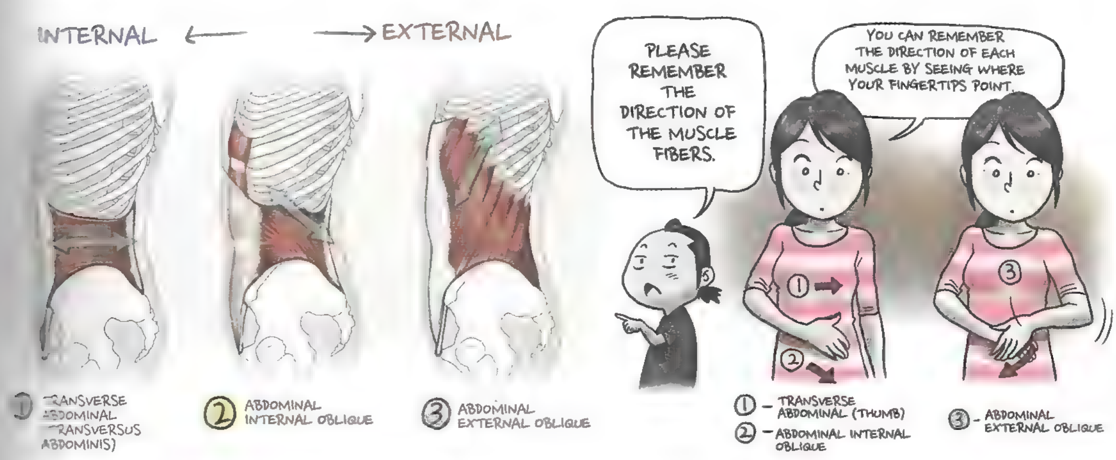


Major Muscles of the Stomach

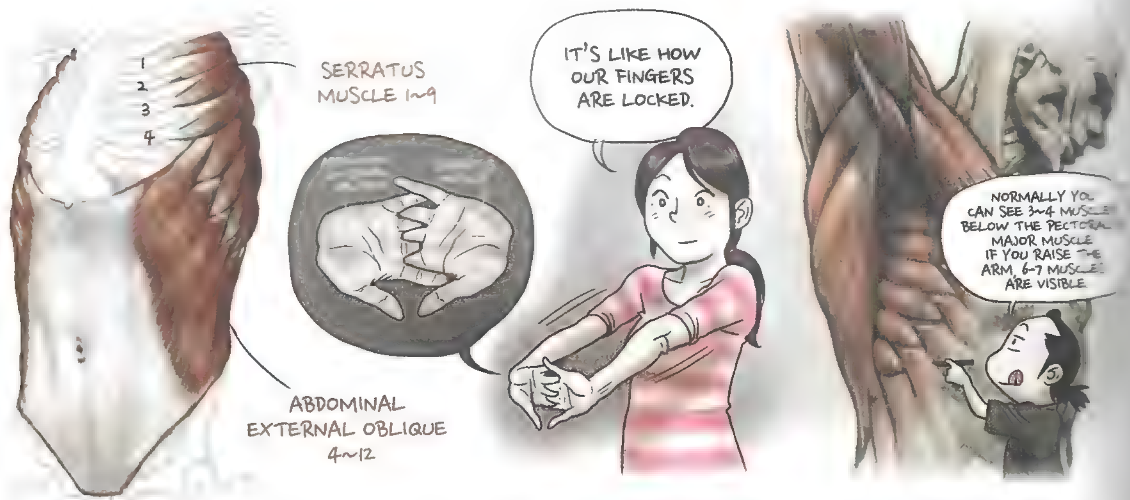
Abdominal muscles function as fexor muscles of the entire body. Just like chest muscles, there are four main abdominal muscle groups. One of the four main muscles is the rectus abdominis which allows the body to fold forward. The other three muscle groups (oblique muscle) allows the body to fold sideways. Bending the body forward and sideways is the same thing but why is there a difference in the number of muscles?



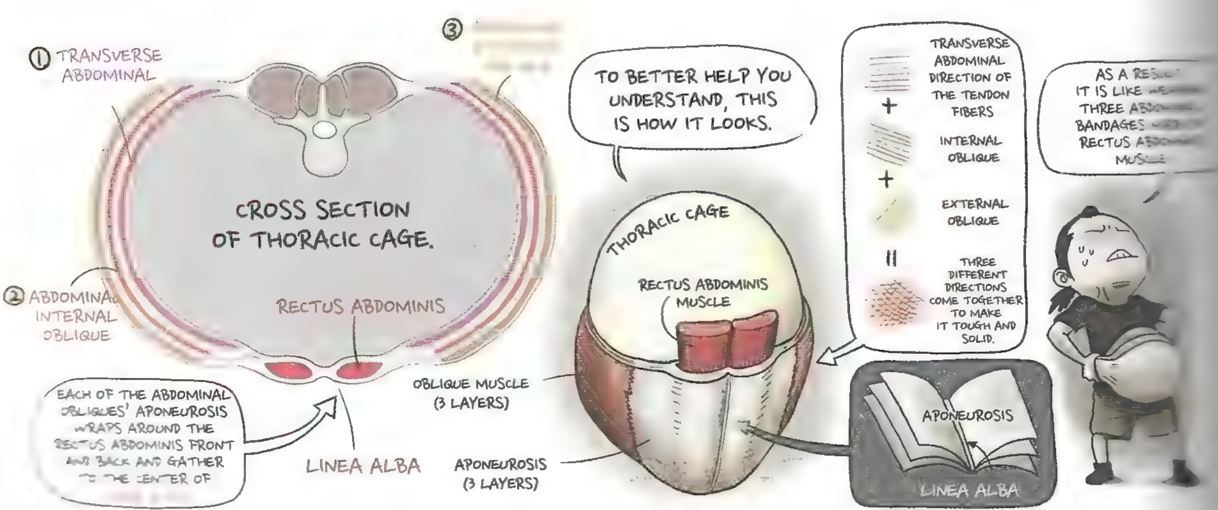
There is an important reason why the oblique muscle is divided into three muscle groups. Let's go over each of the three muscle groups of oblique muscles first. Starting from the innermost layer, there is the transverse abdominal (abdominis), the abdominal internal oblique and the abdominal external oblique.



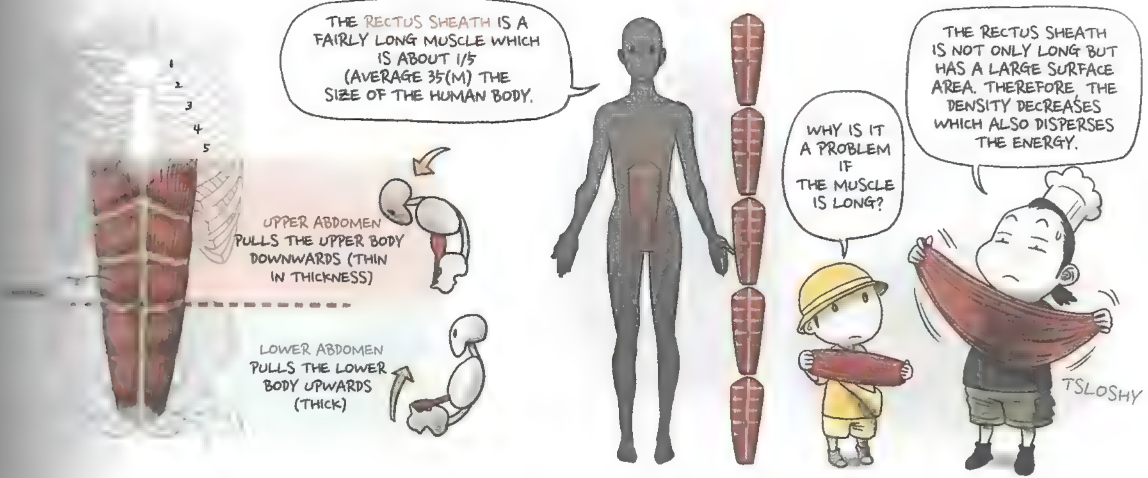
Because the transverse abdominal muscle and abdominal internal oblique lies beneath the external oblique, the appearance of the external oblique is important. You should pay special attention to muscle that runs diagonally from the 4th to the 12th ribs closely as this muscle is interlocked with the serratus muscle that we discussed earlier. It is interlocked in the same way fingers are locked. This appearance becomes an important point when drawing.



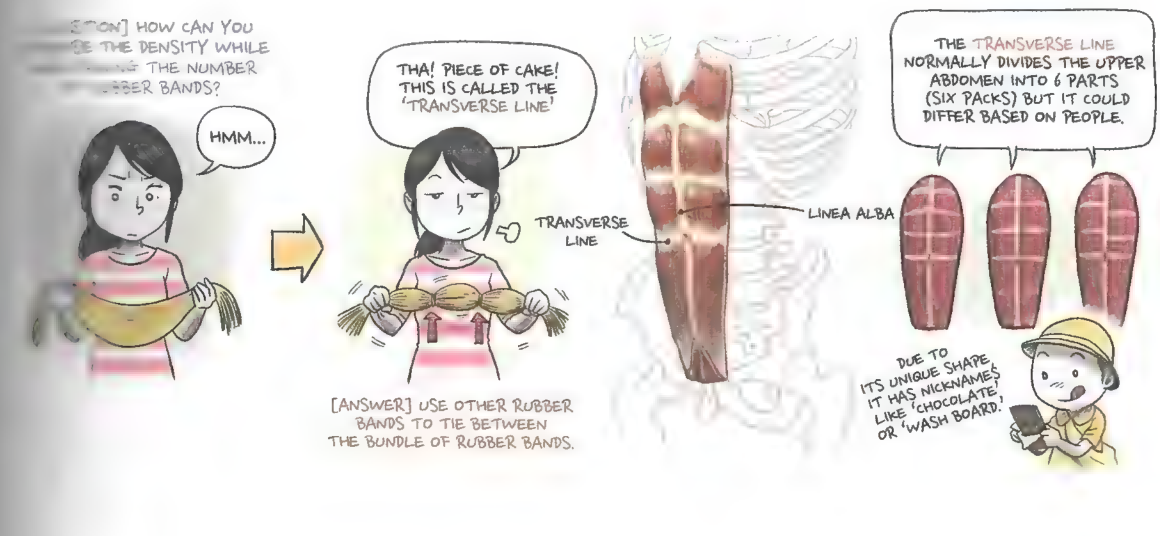
When we look at the abdominal external oblique including the flanks, we can see that the tendons are very wide. I have already mentioned that these tendons are called aponeurosis. If the muscle has three layers, that means the aponeurosis also has three layers which results in the front abdomen having a tough and solid defense barrier. This defense barrier runs into the midline of the abdomen called the linea alba.



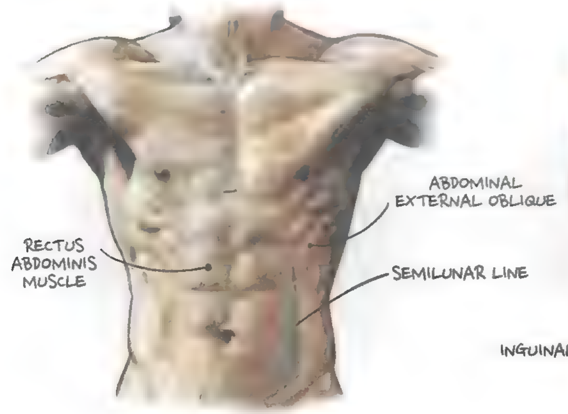
rectus sheath is formed by the aponeuroses of the oblique muscle is already well known ... don't need to explain further. This muscle requires a lot of strength as it functions to pull the ... portion of the body to the lower portion and vice versa. The problem is that this muscle is ... than you can imagine.

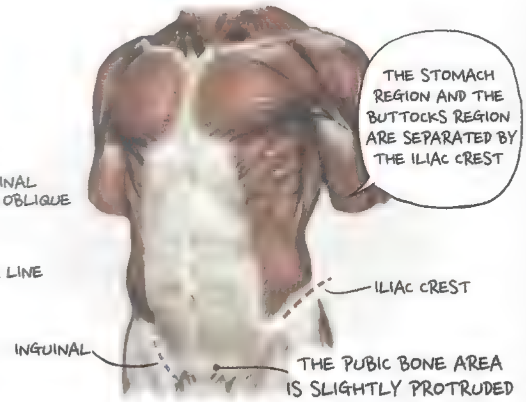


... is troublesome since we can't shorten the length of the muscle. In order for the rectus ... nis muscle to retain strength, it needs to increase the density of the core by knotting the ... in between. We call the line that divides the rectus abdominis muscle into upper and ... transverse line. Of course, it depends on people, but normally there are 3~4 above the ... which is in the middle of the rectus abdominis muscle. When linea alba, which divides the ... from left to right, comes into place the muscles we call 'six packs' are formed.



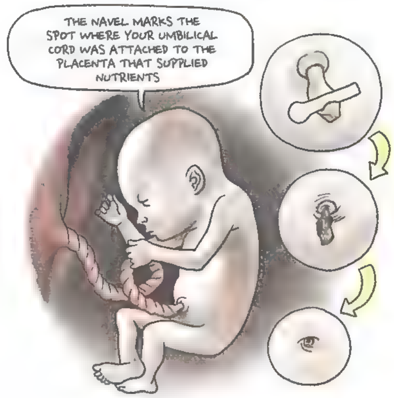
The coexistence of the rectus abdominis muscle and the abdominal external oblique causes several unique visual characteristics in the abdomen. Firstly, a long triangular-shaped aponeurosis area appears which becomes concave as the core develops more. This area has no particular name, but a semicircular-shaped semilunar line is formed by the external oblique functions an index. You should also pay attention to where the belly ends, that is, the point where the abdominal muscles come into contact with the pelvis.

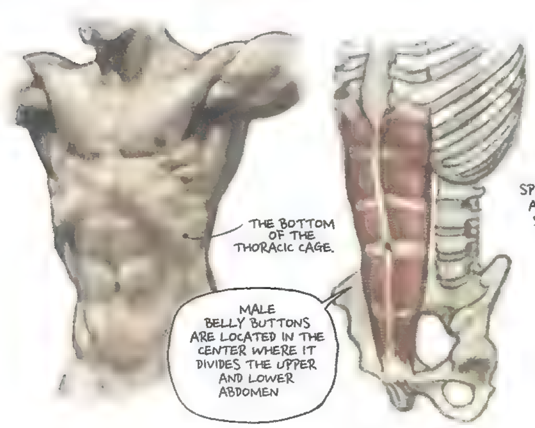


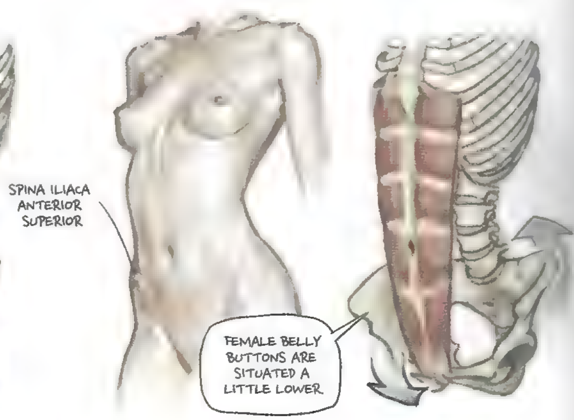


Also, don't forget about the 'navel' which is an important index of the body, even though it is not relevant to the muscles.

The navel marks the spot where the umbilical cord was once attached, carrying nutrients to the fetus in the mother's womb.
The navel has no function once you are born, but it acts as an index to determine many anatomical facts, and moreover is an important aesthetic point.



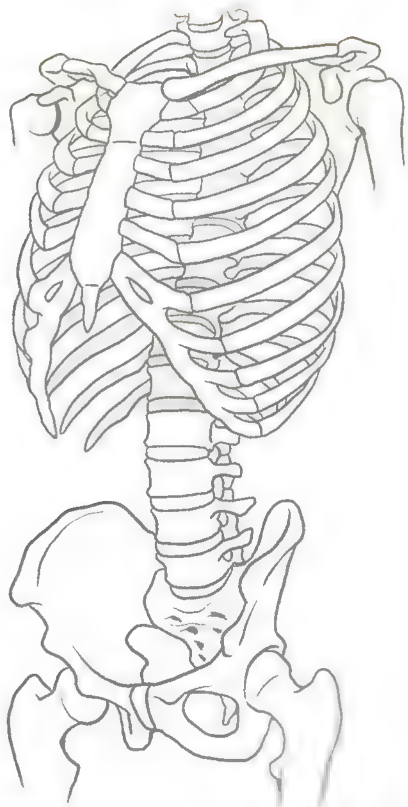




We are all aware that fat deposits on our abdomen. Therefore, it is fairly difficult to observe the muscles explained above. Even though it is tough, it is crucial to observe your stomach because not only do these muscles form the foundation of the belly parts, but they are also used as material when drawing an ideal person.

Let's Try to Attach the Muscles

Let's try to attach the abdominal muscles one by one. You should try to draw the empty area in the center of the body as if it's covered with a thick cloth. Don't forget to pay attention to how the abdominal external oblique and serratus anterior muscle interlock with each other.



● The body

Chest and abdominal part excluding the head, arms, and legs.

01. Quadratus lumborum muscle

02. Transversus abdominis muscle

03. Rectus abdominis muscle

04. Internal oblique abdominal muscle

05. External oblique abdominal muscle

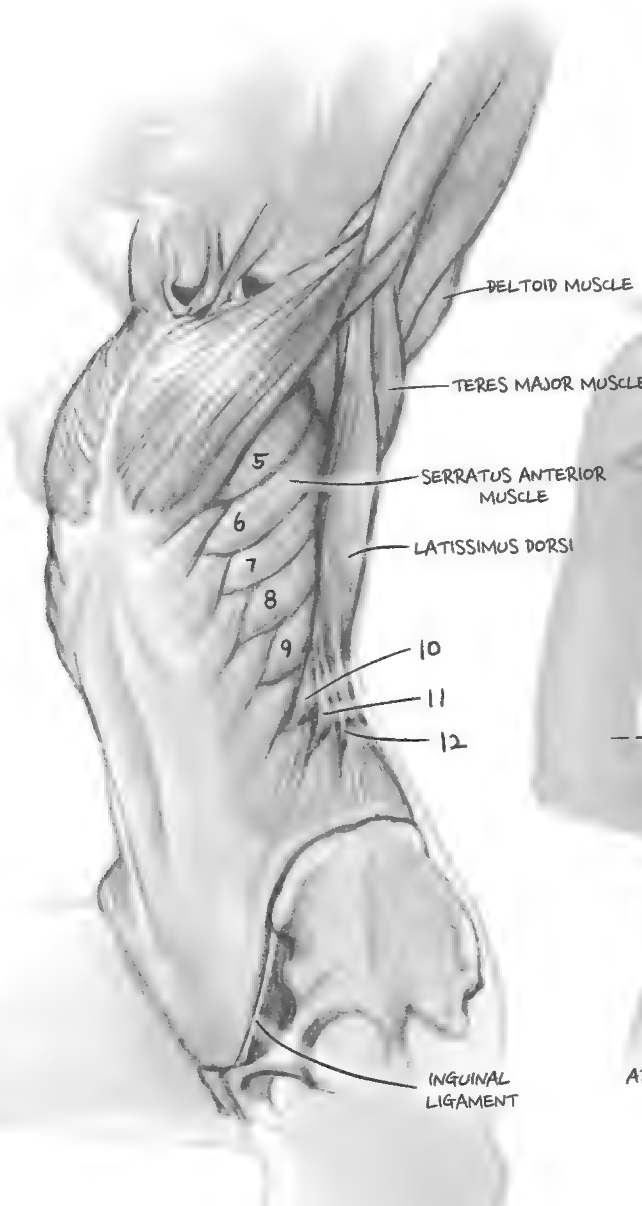
06. Serratus anterior muscle

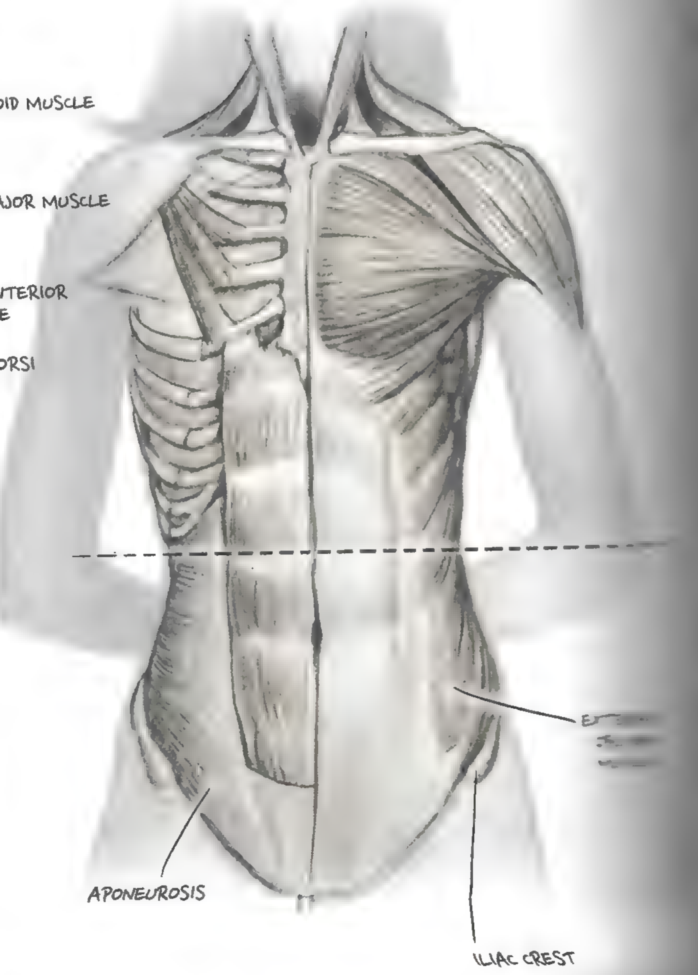
07. Pectoralis minor muscle

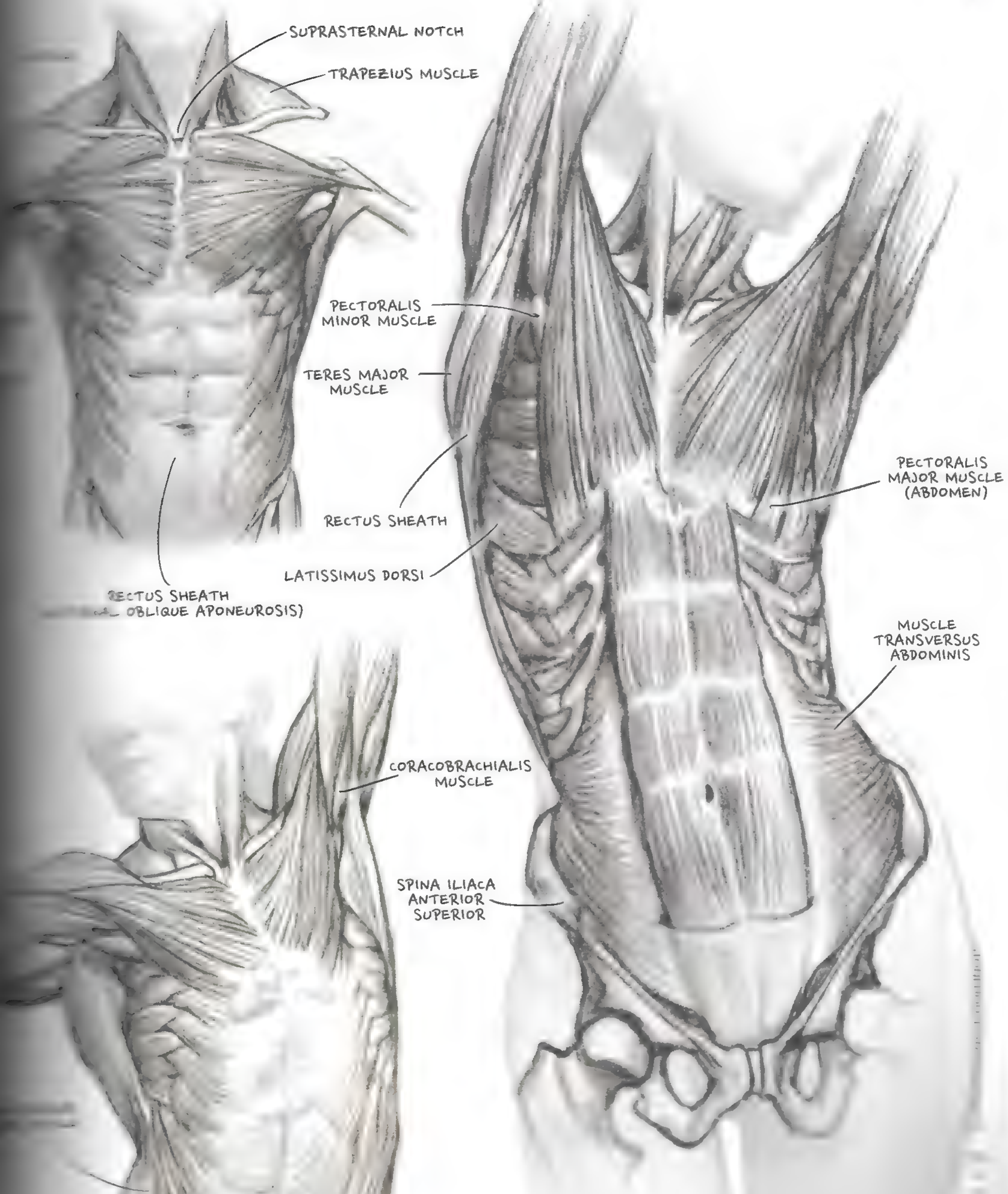
08. Figure when chest muscle is combined

■Different Shapes of the Torso from the Front

Below are some examples of the torso that I drew based on what I explained.
Observe how the muscles are visible below the skin, and take special note of the armpits whe
the chest and arms overlap because this part can be confusing.


DELTOID MUSCLE
TERES MAJOR MUSCLE
5
SERRATUS ANTERIOR MUSCLE
6
LATISSIMUS DORSI
7
8
9
10
11
12
INGUINAL LIGAMENT

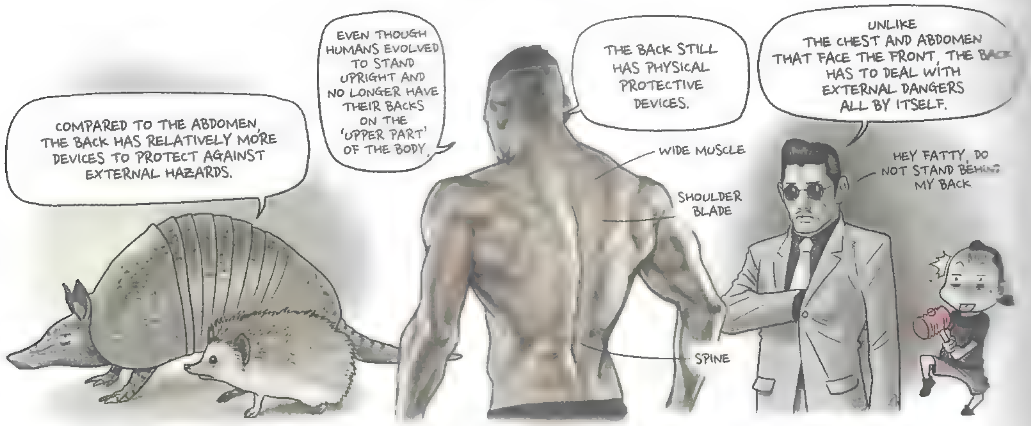

APONEUROSIS
ILIAC CREST


SUPRASTERNAL NOTCH
TRAPEZIUS MUSCLE
PECTORALIS MINOR MUSCLE
TERES MAJOR MUSCLE
RECTUS SHEATH
LATISSIMUS DORSI
RECTUS SHEATH
OBLIQUE APONEUROSIS)
PECTORALIS MAJOR MUSCLE (ABDOMEN)
MUSCLE TRANSVERSUS ABDOMINIS
CORACOBRACHIALIS MUSCLE
SPINA ILIACA ANTERIOR SUPERIOR

Back Muscles

■Let's Look at the Back

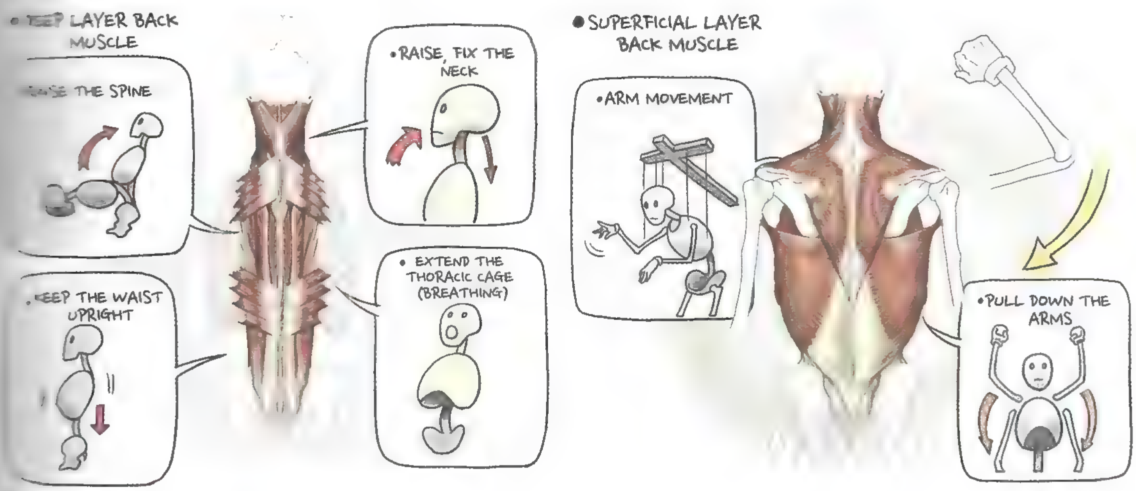
Everyone knows where the 'back' is. The back is situated on the opposite side of our chest a abdomen on the back part of the upper body, if you'll forgive the pun. But unlike with humans backs of four-legged vertebrates are located on the 'upper part' of their anatomy. If we thin it, the most dangerous things usually drop from above rather than rise from the ground. More it is more difficult for the sensory organs of the brain to assess situations from the back. To up for these vulnerabilities, the 'back' has greater protection physically compared to the 'che and 'abdomen.'



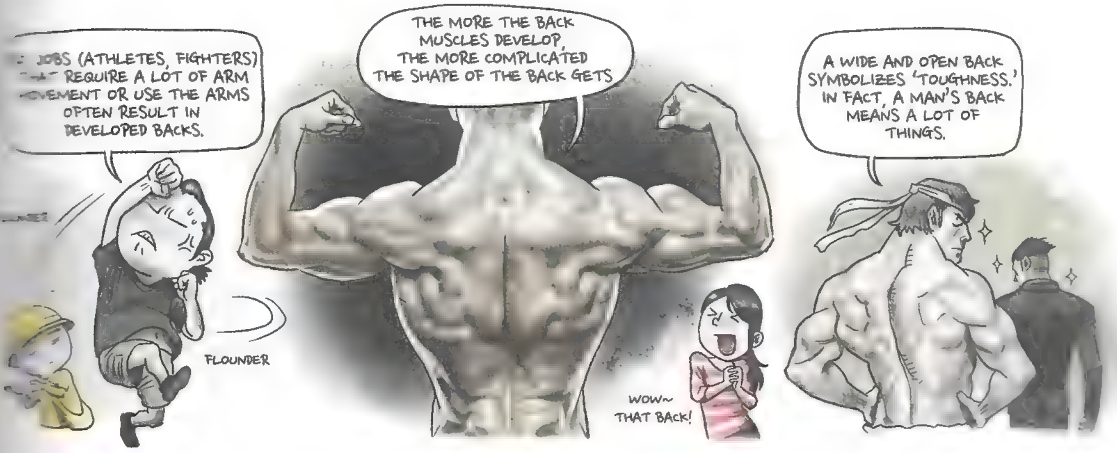
If you can't agree with this instantly, think of scenes from movies and TV shows.
When the main character gets attacked by a group what posture does he or she take instinctively?

The back muscles can function in more diverse roles compared to the chest and abdomen because the back doesn't carry the load of protecting the heart, lungs and stomach. Since humans used to walk on all fours, we share this similarity with other vertebrates. But while the thoracic cage of four-legged vertebrates is more pointed toward the front and back, the thor cage of humans is wider to the sides, giving humans wider backs. Having said that, quick question for you! What is the function of the back muscles?

...t like our chest muscles, the back muscles can be differentiated by deep layer muscles and ...perficial layer muscles. Deep layer muscles mainly move the ribs to aid breathing as well as ...ction as an 'extensor muscle' by resisting the rectus abdominis muscle to raise the body. The ...perficial layer muscles, on the other hand, are closely related to the movement of the 'arm.'



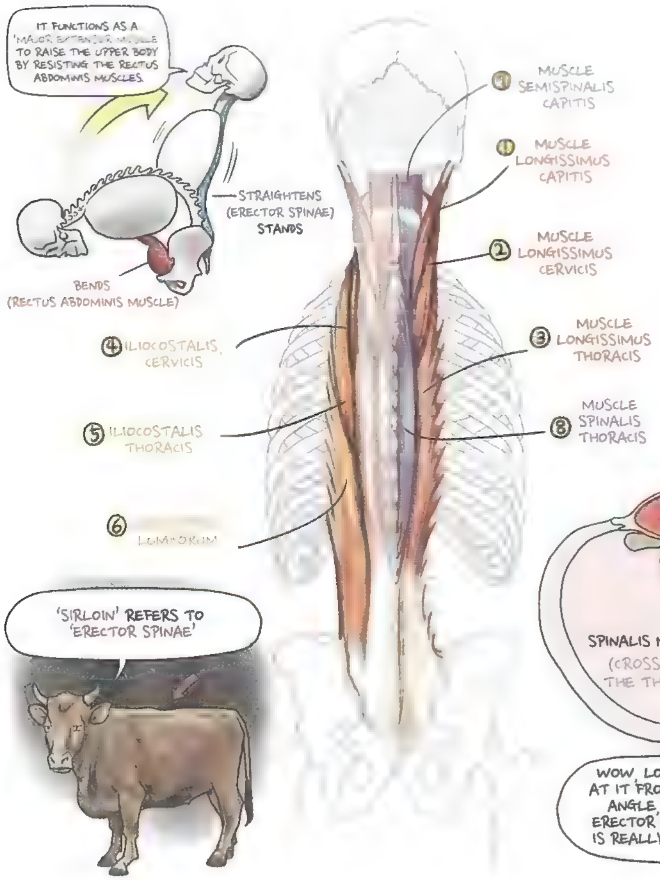
...ce these muscles are wide in size, the aponeurosis has a unique shape which forms a ...aracteristic and convoluted shape as the back muscles get more developed. With that said, a ...e back and developed back muscles symbolize and indicate 'power.' It's also an interesting ...t to design.

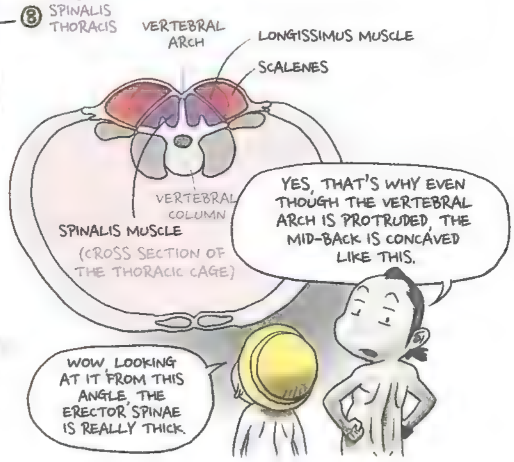


■Major Muscles of the Back

Let's take a closer look at each of the back muscle.

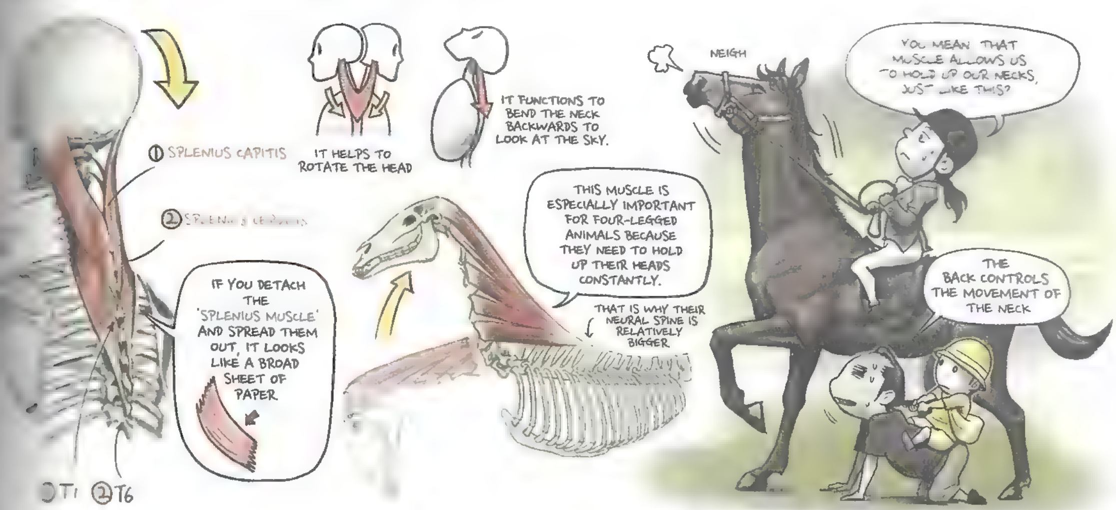
Firstly, the erector spinae, which lies on each side of the vertebral column, allows the basic movement – 'straightening the back.' Maintaining the body requires more energy than bending the upper body forward, the three lumps of muscles are combined into one.





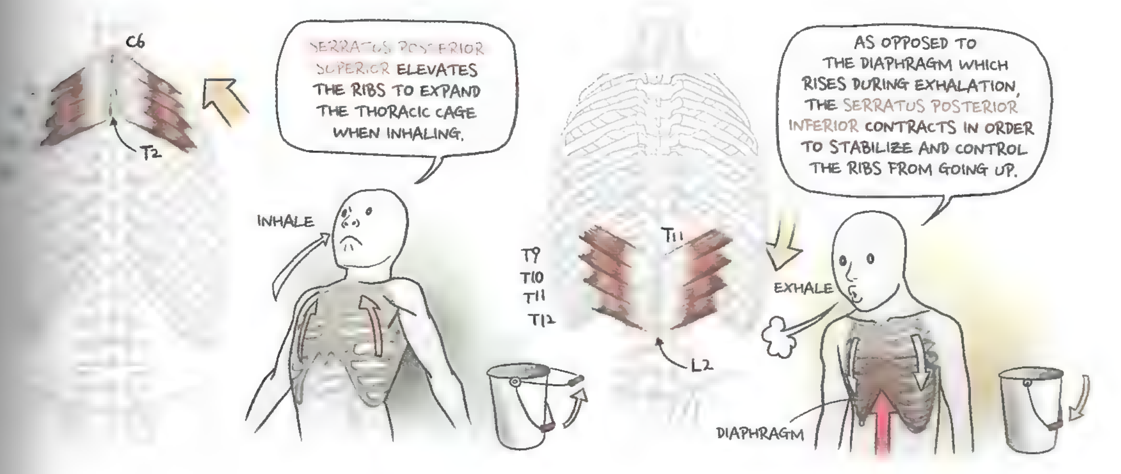
The function of the erector spinae is to straighten the back, but it needs an assistant muscle to help perform this laborious duty. The assistant muscle is called the quadratus lumborum muscle because it is in the shape of a quadrangle. It is situated between the 12th rib and the upper part of the pelvis to help the body stand straight.

splenius capitis muscle and splenius cervicis muscle start at the spine (neck and chest and cover the back of the head and the transverse process of the neck respectively, they from a "V" shape. When these muscles function separately on each side, it aids the leidomastoid muscle to rotate the head. But when they contract together, it straightens the Put it simply, both muscles
d the head back. Four-legged animals that need to straighten the head while walking have oped splenius capitis and splenius cervicis.

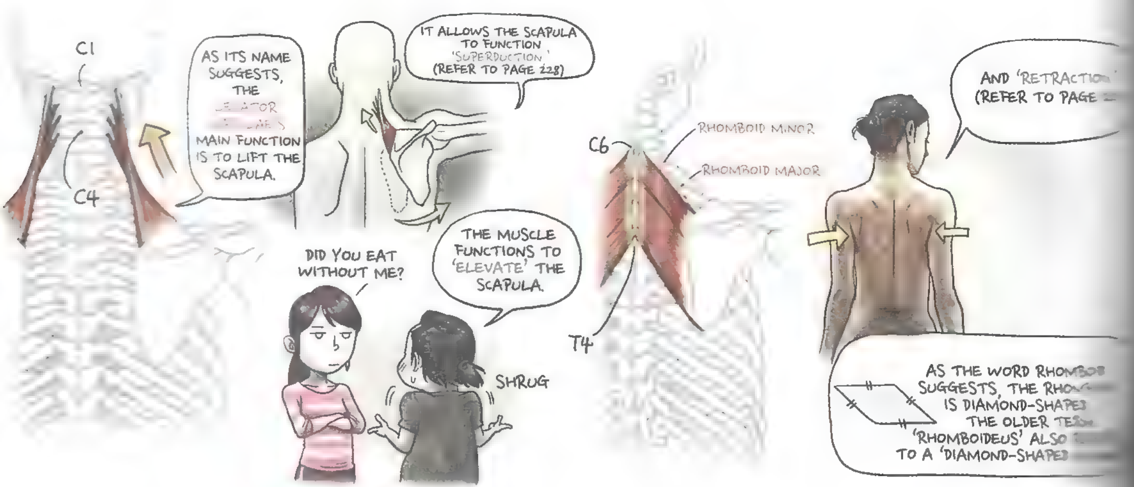


Pigs are an exception. They have splenius but their skeletal structure does not allow them to bend their necks more than 10 degrees.

entioned briefly in the earlier part of the chest muscle chapter, the intercostal muscle s the ribs to help breathing. Just like the intercostal muscle, the serratus posterior superior/ r muscles pull the ribs from the back to help the lungs with respiratory movement. As with rratus anterior muscle that we learned about earlier, it is also called the serratus muscle as s like a sawtooth fish.



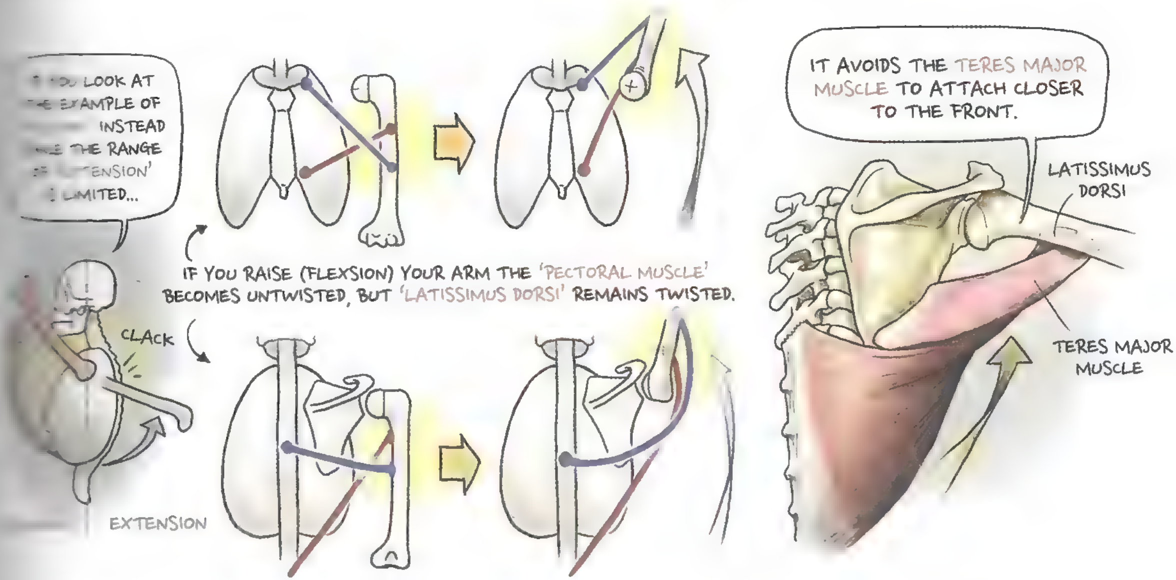
If the previous pages dealt with the muscles related to respiration and vertical motion, this page will delve into the muscles related to arm movement. The levator scapulae and rhomboid act to retract the scapula, pulling it towards the vertebral column, thus enabling the arm's 'superductio (supraduction' and sublation (refer to page 314). Rhomboid' act to retract the scapula, pulling it towards the vertebral column.



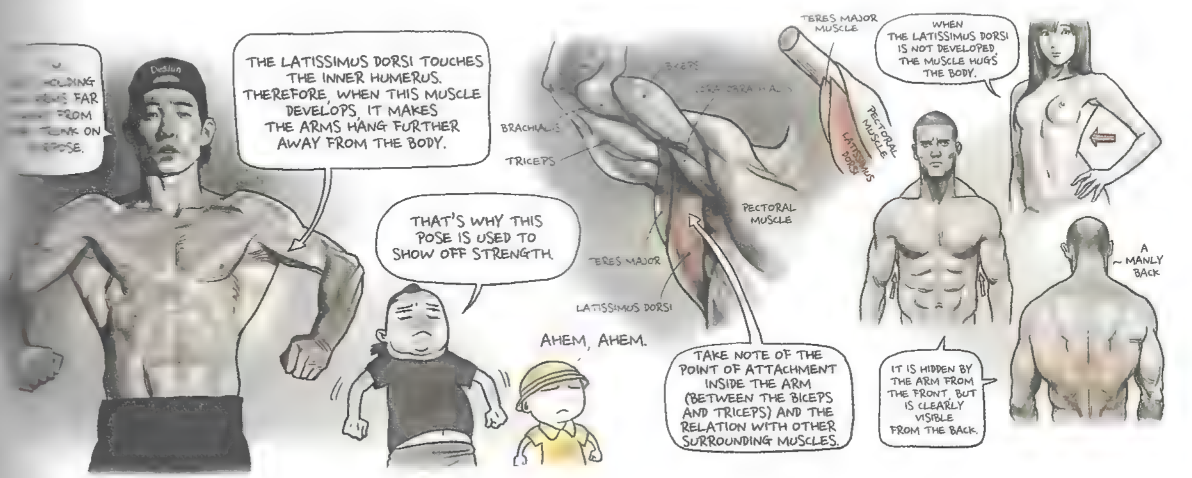
Anyone who likes the famous *action star Bruce Lee or who* is interested in working out will all know about the latissimus dorsi muscle.

The latissimus dorsi is a large, flat muscle on the back which originates along the thoracic vertebra (T7) *region of the spine and extends to the sacrum.*
The muscle also covers the inner arms. The word latissimus dorsi comes from Latin and means "broadest muscle of the back." This muscle is responsible for adduction of the arms such as pulling or moving arms down to the sides of the body. It plays an important role when performing a pull-up.

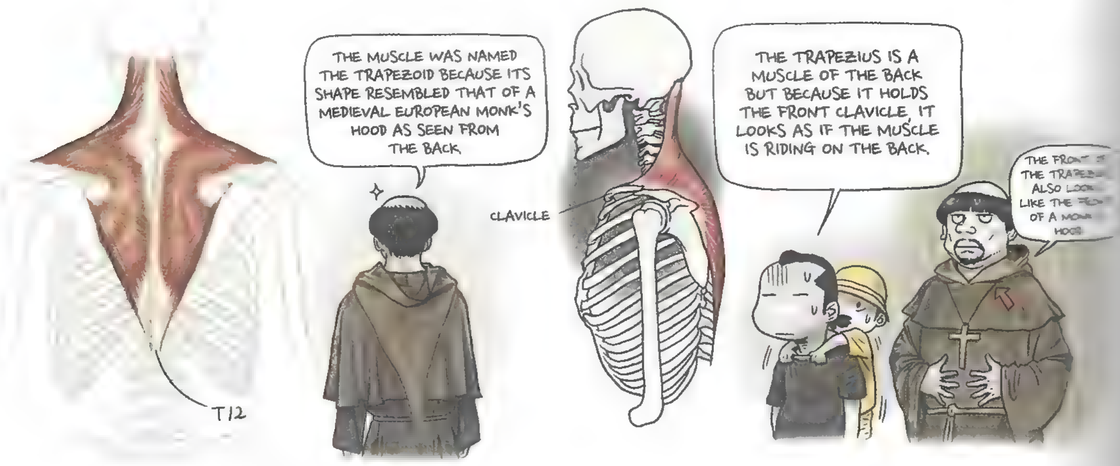
...u look at the latissimus dorsi closely, there is an interesting twist to the limb. The insertion ... touches the inner arm is literally twisted when the arm is down by your side. This is similar ... pectoral muscle we learned about earlier, but while the pectoral muscle has three ... twisted in order, the latissimus dorsi is one muscle and twists even more when the arm .... This characteristic makes it possible to pull down the arms more strongly.



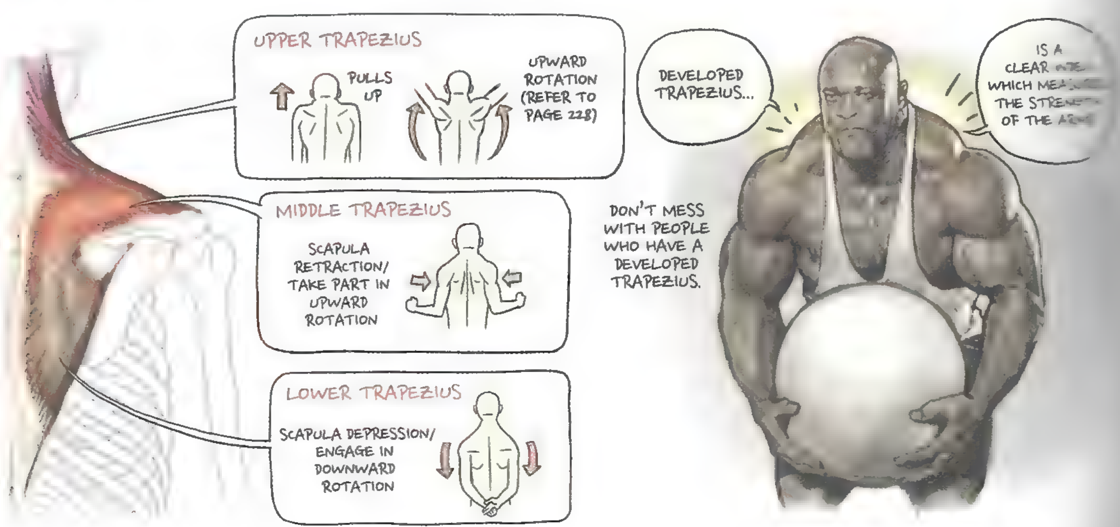
...cause it is the broadest muscle in the body, the visible appearance of the latissimus dorsi is ...pressive. This makes it an essential index when drawing figures, especially that of a muscular ...n. One thing to be mindful is that the muscle originates from the back, but it touches the inner .... Therefore, the muscle is visible only in the front when both arms are open. It is just like a ...ng hidden in an armpit. Of course, we can't spot that muscle in every person.



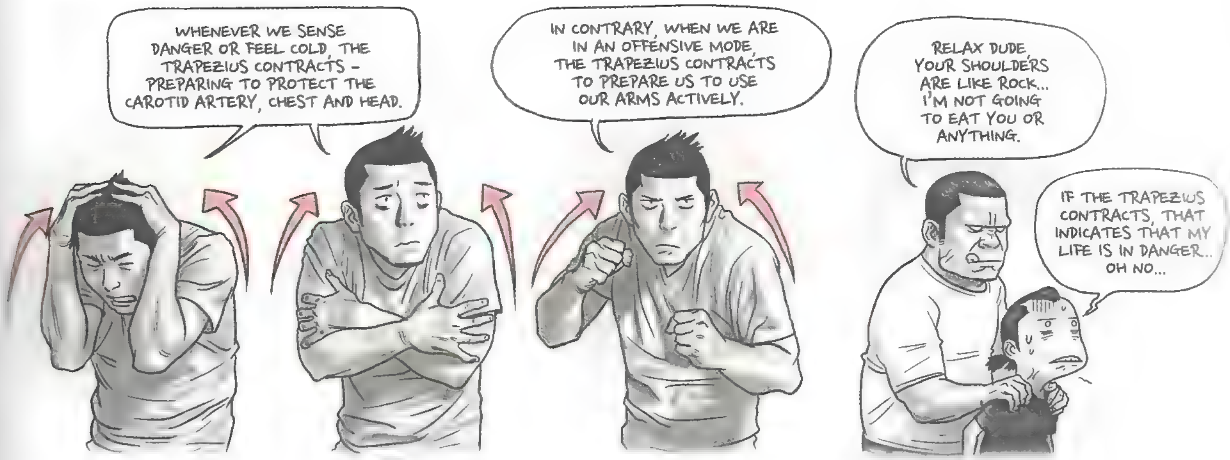
If the latissimus dorsi is the muscle that pulls and moves the arms down, the trapezius is one of the major muscles of the back that is responsible for controlling almost all movements excluding lifting the arms or bringing the arms together to the front. Ultimately, because the trapezius is responsible for most of the arm movement, we can say that the trapezius is the 'owner of the arms.' This muscle not only stabilizes the scapula (shoulder blade) but it also covers the clavicle.



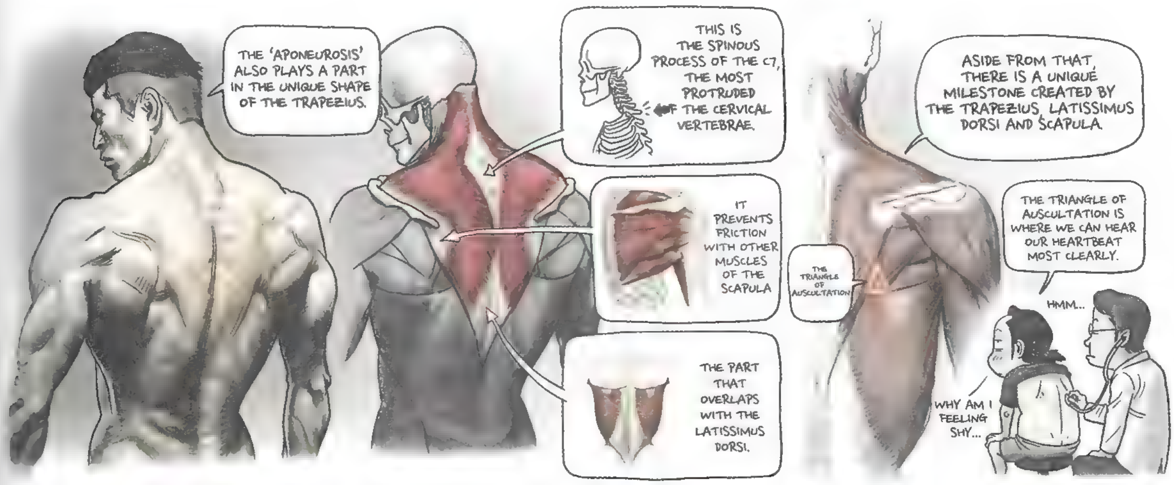
As this superficial muscle covers various areas, the function of the trapezius is quite diverse, too. The trapezius is responsible for moving, rotating and stabilizing the scapula based on the direction of the fibers and for opening the chest or bending it to the sides. It is also responsible for raising up or rotating the neck. But more than anything, because the trapezius is related to the scapula which is the starting point of the arms, using the arm muscles will develop the trapezius as well.



Whenever we sense danger, we instinctively shrink our neck and shrug our shoulders. This is to protect the carotid artery by contracting the sternocleidomastoid as well as to prepare us for defending ourselves by contracting the trapezius. When we get stressed or nervous for a long period of time, the trapezius contraction continues and makes our neck grow stiff and our shoulders become tense.



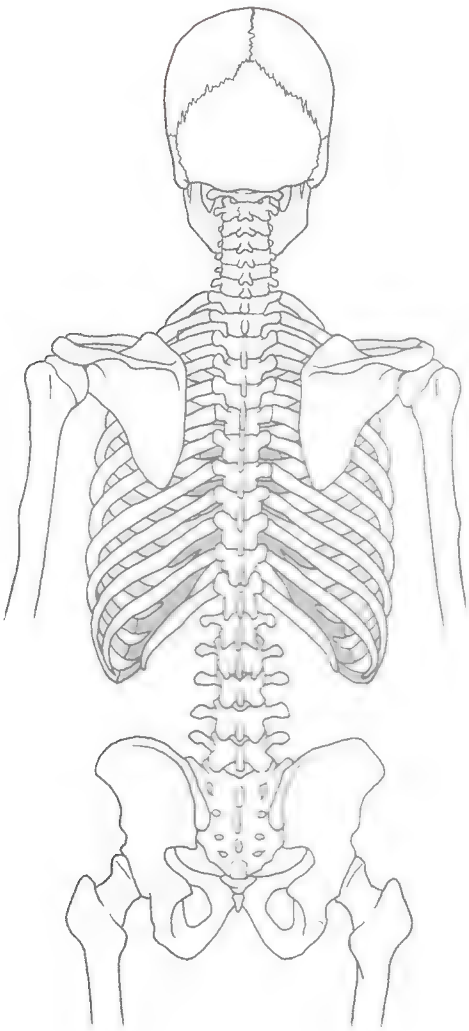
When looking at the trapezius, it is important to observe the shape of the aponeurosis. Because there are various functions of the muscles, the shape of the aponeurosis is also unique, so it is important to understand why the tendons look the way they do. I have mentioned many times that as the aponeurosis develops, the convoluted form of the aponeurosis also stands out, which also affects the appearance of the back.



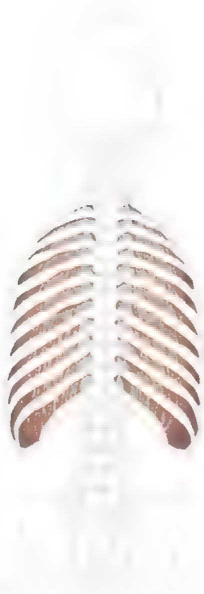
Attaching the Back Muscles

It is now time to attach the back muscles in order. As the role of the deep muscles and superficial muscles is clearly differentiated, it is more effective to study each function of the muscles instead of memorizing the muscles in order. For your reference, the muscles starting from the scapula can be considered superficial muscles.

Axial Skeleton (Back)



01. External/Internal intercos
muscle

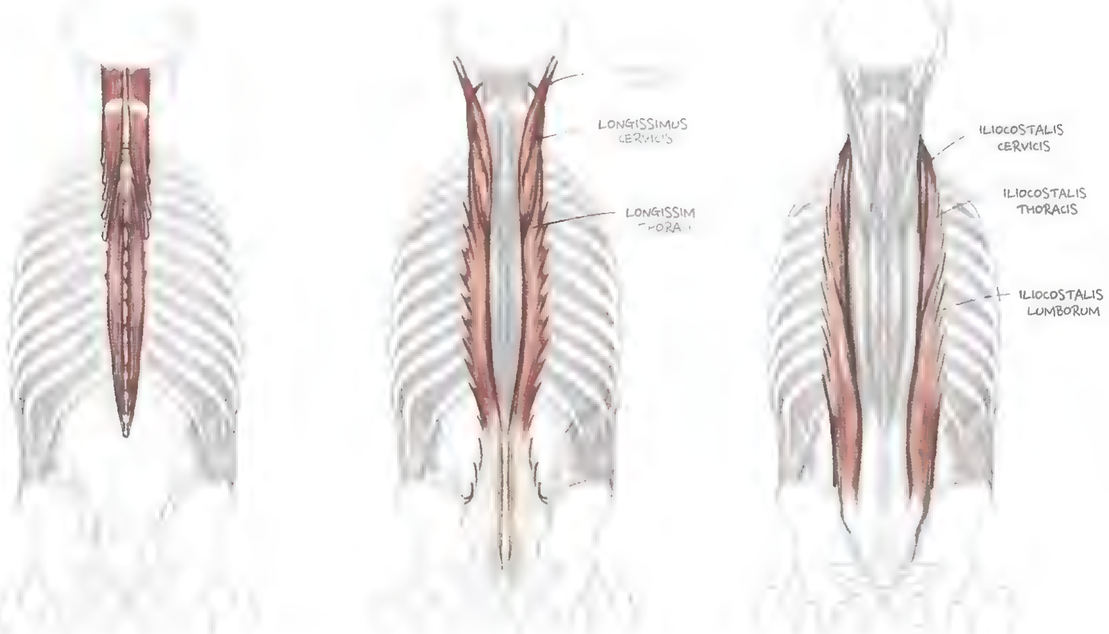


02. Quadratus lumborum

03.Transversus abdominis

04. Internal oblique abdominal muscle

05. External oblique abdominal muscle

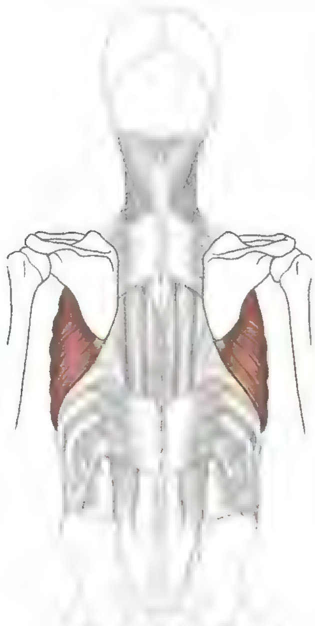


06. Erector spinae (muscle spinalis, longissimus muscle, iliocostal muscle)

07. Splenius cervicis

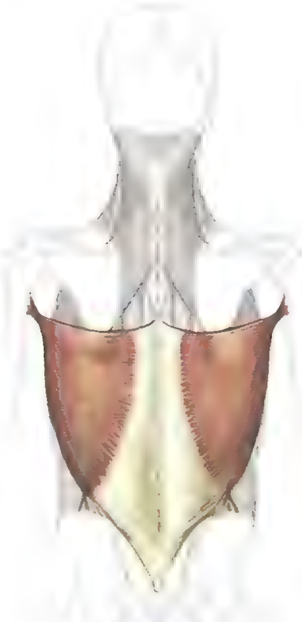
08. Spenius capitis

09. Serratus posterior superior/ serratus posterior inferior



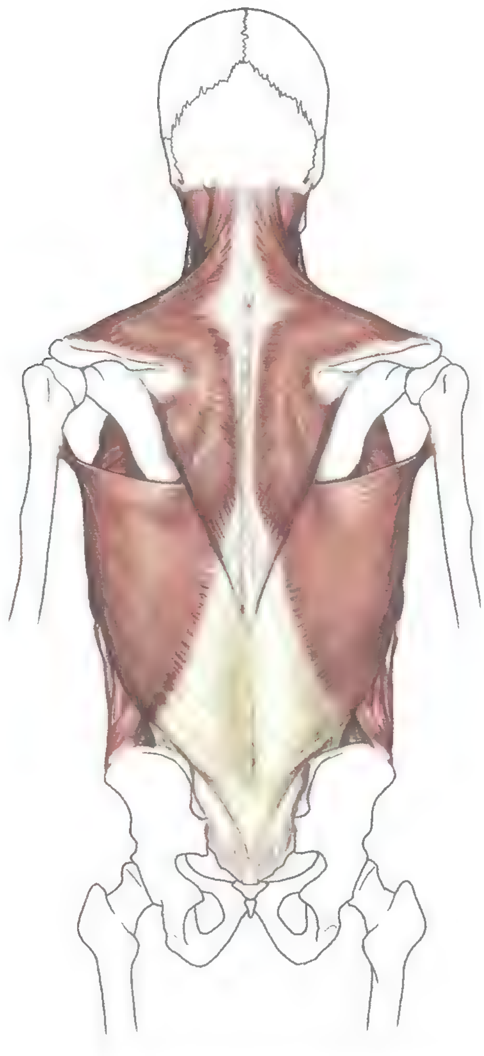
10. Serratus anterior

11. Levator scapulae/rhomboideus



12. Latissimus dorsi

13.Trapezius



14. Completion of back muscles

Different Figures of the Back

As I mentioned briefly before, the back has many forms depending not only on the degree of muscle development, but also on the direction of fibers and the shape of the bones and tendons. The erector spinae is a deep muscle but is extremely thick, which makes it visible throughout the entire back and on the waist, especially when the upper body is in an upright position. Also pay attention to the neutral spines that show between the muscles when we bend our upper body.

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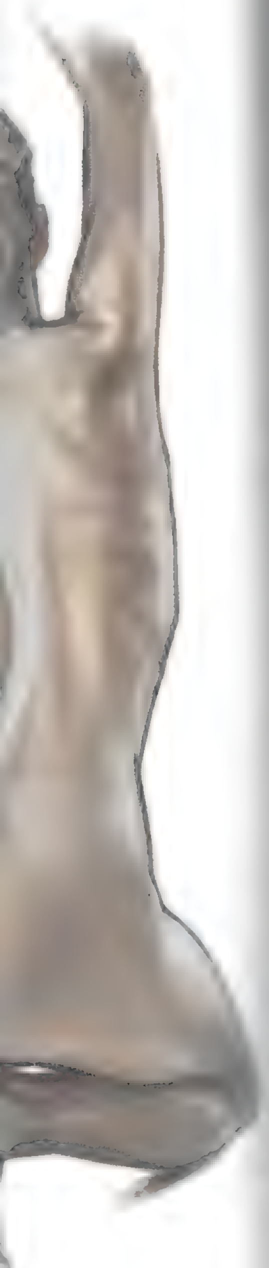
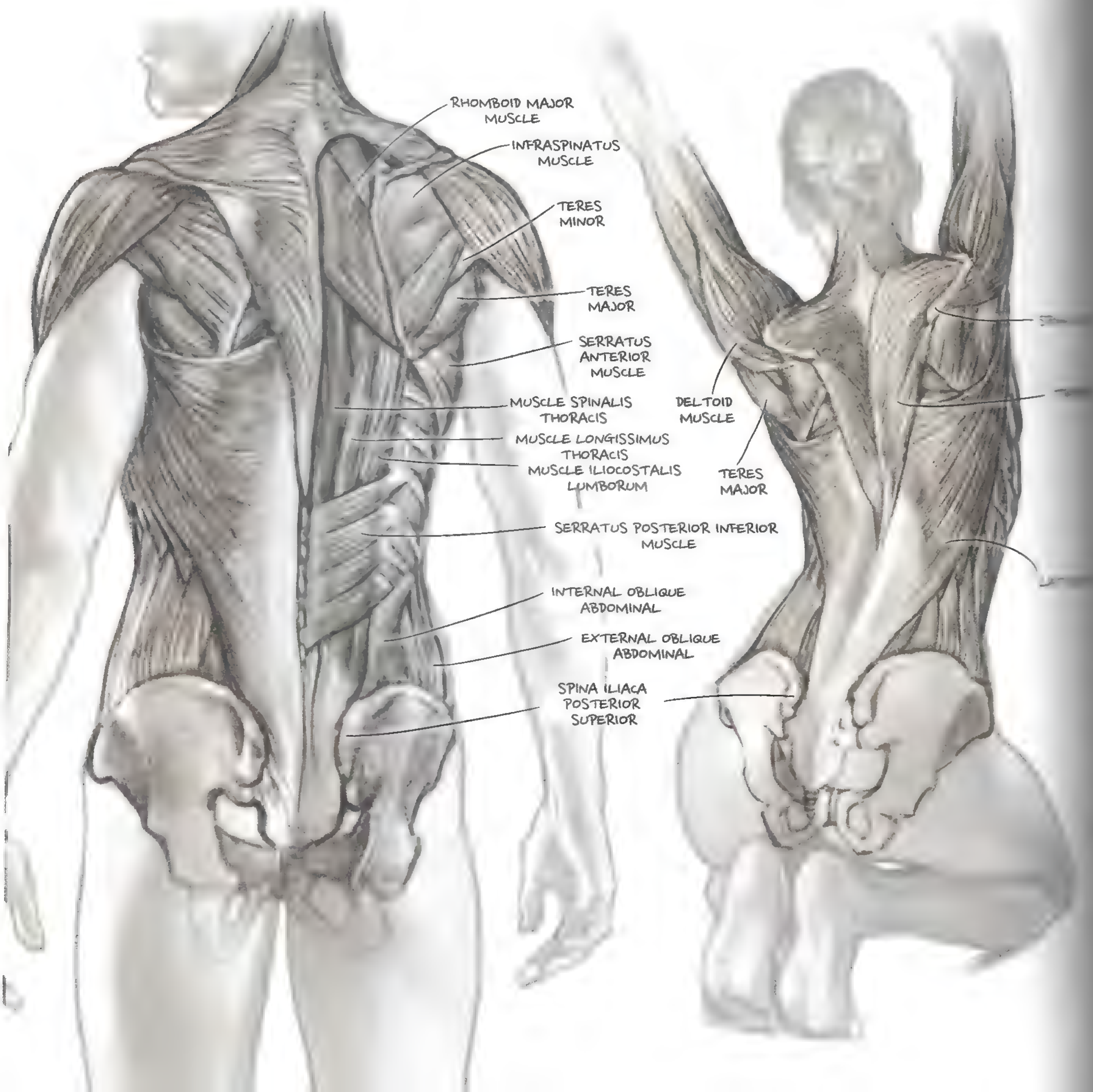
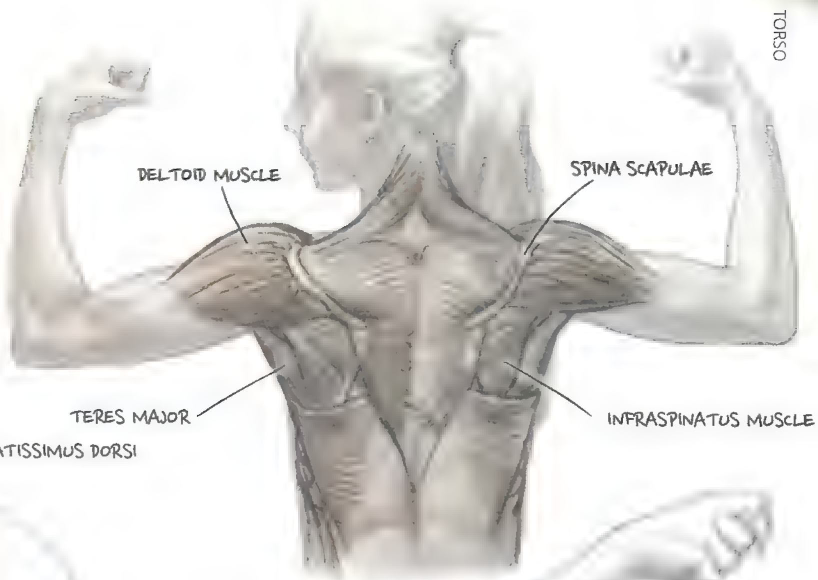
upper body.

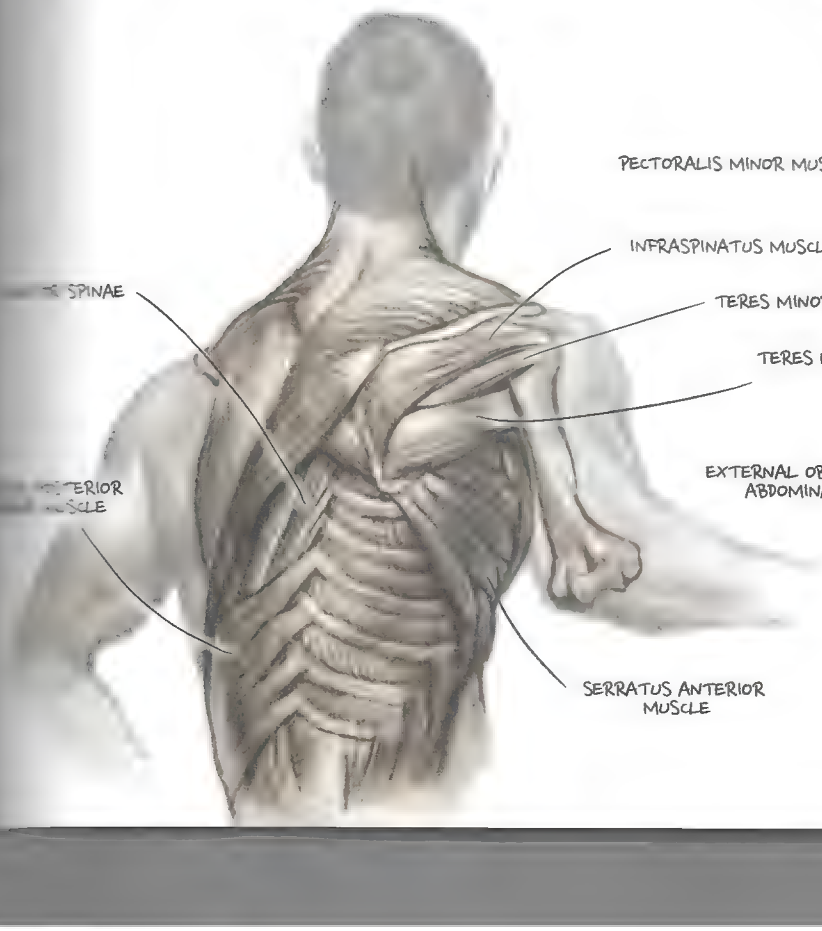


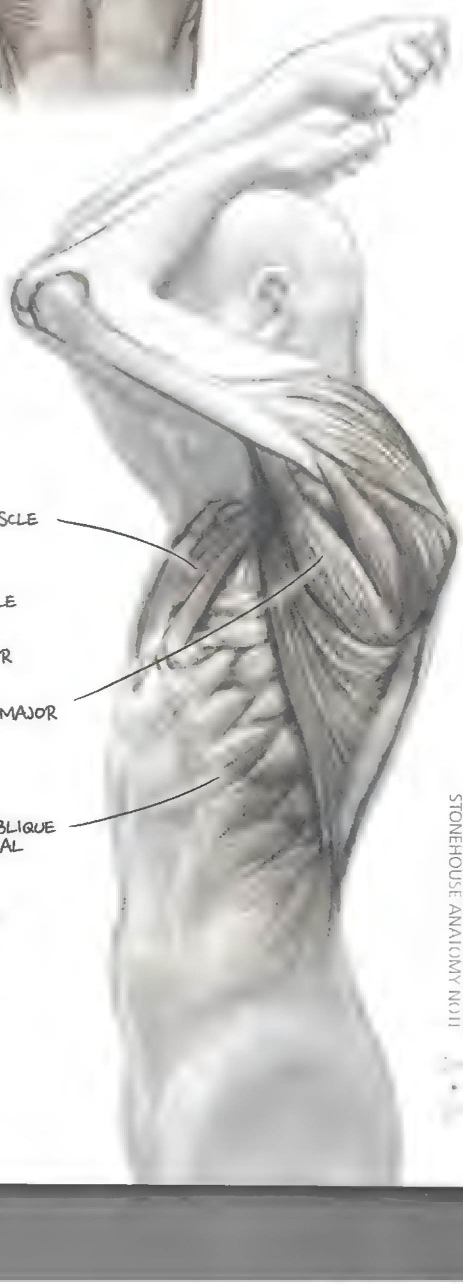


RHOMBOID MAJOR MUSCLE
INFRASPINATUS MUSCLE
TERES MINOR
TERES MAJOR
SERRATUS ANTERIOR MUSCLE
MUSCLE SPINALIS THORACIS
MUSCLE LONGISSIMUS THORACIS
MUSCLE ILIOCOSTALIS LUMBORUM
SERRATUS POSTERIOR INFERIOR MUSCLE
INTERNAL OBLIQUE ABDOMINAL
EXTERNAL OBLIQUE ABDOMINAL
SPINA ILIACA POSTERIOR SUPERIOR
DELTOID MUSCLE
TERES MAJOR


VERTEBRA PROMINENTE
TRAPEZIUS
LATISSIMUS DORSI
EXTERNAL OBLIQUE ABDOMINAL


DELTOID MUSCLE
SPINA SCAPULAE
TERES MAJOR
INFRASPINATUS MUSCLE


SPINAE
INFRASPINATUS MUSCLE
TERES MINOR
TERES MAJOR
SERRATUS ANTERIOR MUSCLE


PECTORALIS MINOR MUSCLE
EXTERNAL OBLIQUE ABDOMINAL

'Emissary of Justice' / painter 12 / 2015

V
Arm, Hand

The Ultimate Tool

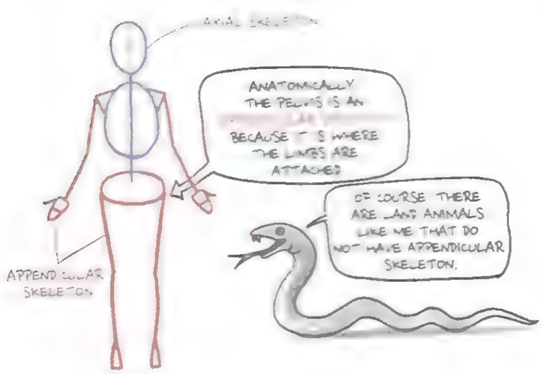
With all the gravity, pressure, and friction that we have to deal with on earth, it is very difficult to move freely using only our head and spine. That is why we use a special means of mobility that's dedicated to movement.

Let's take a look at what role arms and legs play in survival, how they are designed to carry out that role, and how they compare to other vertebrates.

Grasp the Branch!

■Basic Role of Branch

If we could compare the human body to a tree, then we have already covered the 'roots' and 'stems.' The 'roots' and 'stems' of a tree would be the 'axial skeleton' which consists of the head and trunk. Now, the arms and legs we are about to study are the 'branches' of a tree. Like any other organ in our body, the 'branch' plays an important role in survival, but unlike cardiopulmonary function, and digestion it doesn't have a direct effect on vital survival. As such it is called the appendicular skeleton. Just like trimming the branches does not kill a tree, our life is not threatened if we have no arms and legs.

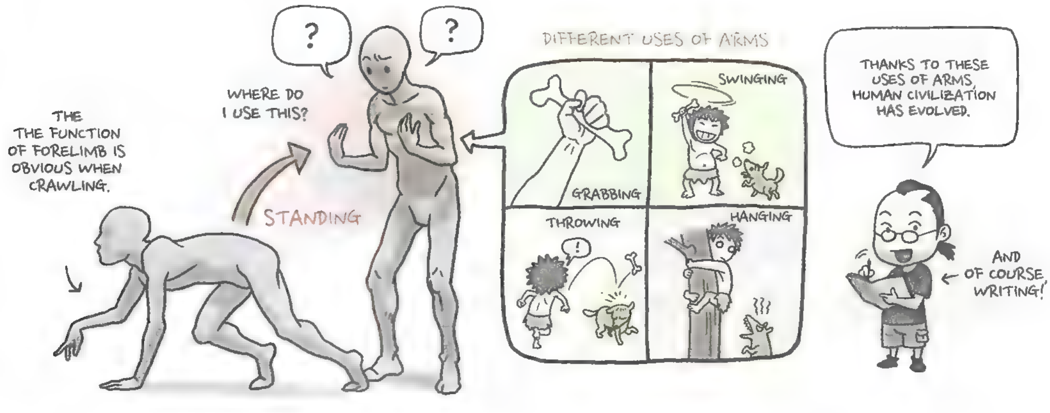


Even if that's the case, we can't deny that the arms and legs have a huge effect on the survival of land animals. Let's think. What are the major functions of the 'appendicular skeleton?'

As you can see, the arm has supplementary functions such as hunting prey and attacking, but the essential function of the arms and legs is of course 'locomotion.' When humans evolved to stand erect, the human forefeet, or arms' main function no longer became locomotion. Still, the arms play a huge part in 'shifting direction' and 'balance' that are the basis of movement.

Human arms play the role of 'tail' of four-legged animals when they move, so without arms, it is difficult to suddenly change directions.

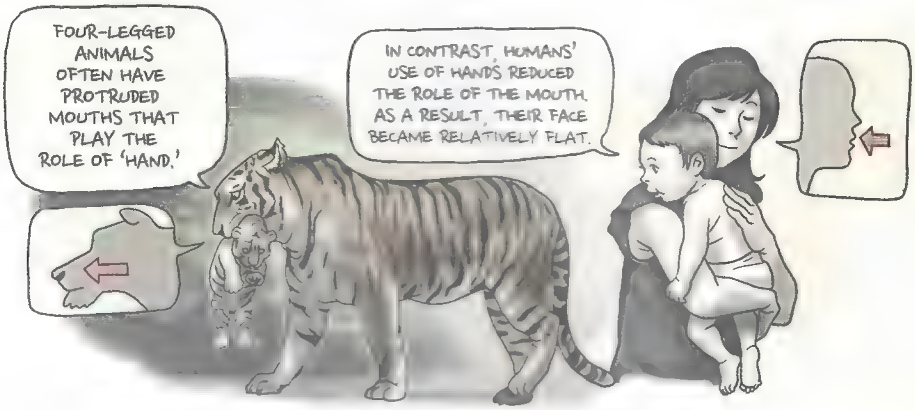
If the major function of arms and legs is 'locomotion,' we can assume that the hind limbs of four-legged animals and humans serve the same function. That being said, we are now going to delve into humans forelimbs, or the arms. Human arms are different from animals' because they are not used only for 'locomotion.' When humans started to stand, our arms and hands evolved to serve other function such as holding things or throwing things.



It is debatable whether standing caused humans to develop their hands to or vice versa, but there's no question that standing brought noteworthy changes to the human body. It is also true that the development of the hands was an inevitable choice for human survival as humans used to be the weakest beings in nature.

Wait! Arm and Face

The change in the role of the 'arm' and 'hand' was such a dramatic event that not only did it affect the overall appearance of the body, but also the appearance of the 'face.'



Just like the picture above, unlike animals that use their mouths to move their babies or to eat, humans use their 'hands' instead of their mouth to do these activities. Gradually, the oral structure of humans started to retract. Along with the jaw protrusion that occurred due to the changes in the size of the brain that I talked about earlier, the role of human hands had a significant impact on forming a human characteristic—a 'flat face.'

If the main function of our hands were solely 'locomotion,' the structure could have been as simple as a stick. However, with the diversification of its uses and roles, the human arm has evolved into a fairly complex structure compared to other terrestrial animals.

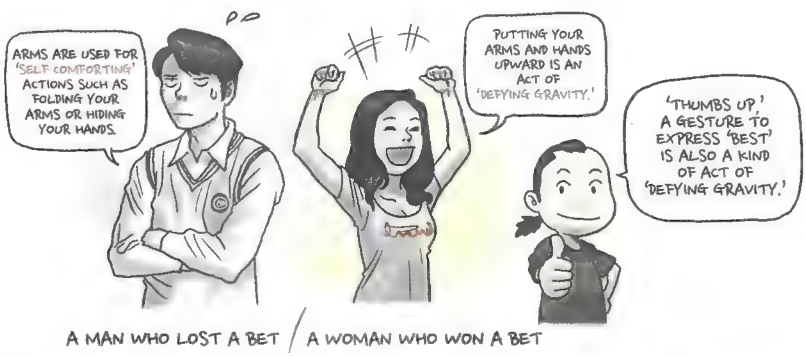
Study of Female and Male arm muscles - painter12 / 2011

We'll be studying more arms later, but just like looking at the picture above, my head starts to hurt. But, please don't worry. As mentioned earlier, no matter how complex a machine is, if we know how it works everything becomes easy. We have to bear in mind one important thing. Every action derives from 'necessity.' Simply put, the structure gets constructed where there's a 'definite reason' behind. That being said, it is crucial to think about the reason why our arms came to an existence.

■The Language of Arm

As I've mentioned earlier, the purpose of the arms is making conscious movements such as moving, grabbing and throwing something. But they have another important function. They act as the 'bodyguard' that primarily protects the brain and cardiorespiratory organs from external physical stimuli or attacks. Therefore, putting the discomfort aside, you would be seriously vulnerable to external stimuli if there were no arms.

The arms instinctively protect the body from external stimuli, and the arms also protect the body from psychological stimuli. The arms react automatically to external stimuli detected by the brain, playing the role of 'simultaneous interpreter.' They reflect the brain's activity in real time just like the eyes (page 81). That is why the arm position a person has when engaged in conversation with another person provides a clue to the behavioral psychology of the person.



The facial expressions of the above people are not the sole indicators that show a state of mind.

Therefore, if you are an artist who is trying to portray the human body, it is very important to understand the 'language' of the arms.
Of course, the same applies to other art performances such as musicals and plays where the audience can't always see facial expressions and emotions. Therefore, the role of the arm becomes even more important in situations where you have to deliver a story with only a fixed screen and no sound or movement whatsoever.

you can see from 'body language' alone, it would be fair to say that every artist in the world owes a lot to 'arms' and hands as these parts can express various stories. It is unnecessary to mention, that arms and hands played a huge role in creating these art pieces.

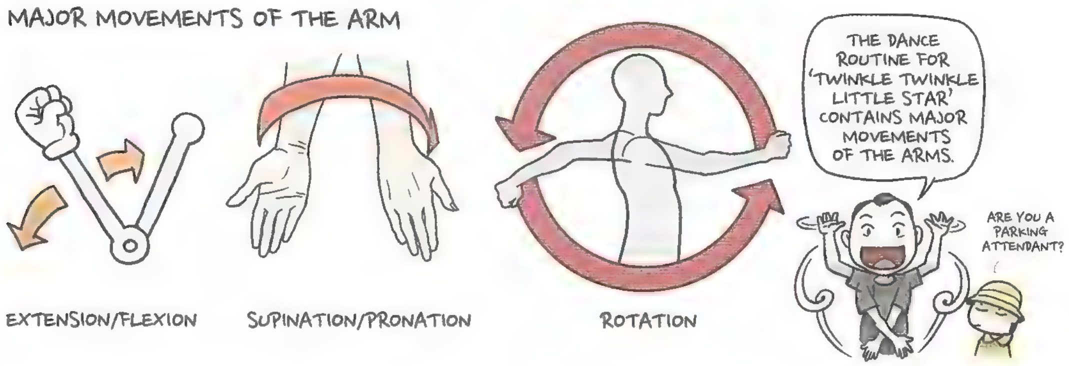
You can create various expressions just by changing your hand's posture

The meaning and role of arms are endless, so let's wrap up the introduction and study the details of the arm one by one.

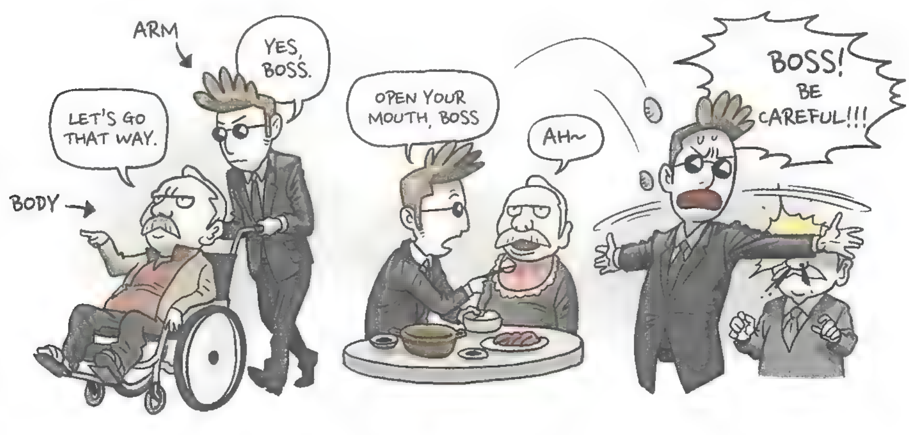
Shrugging the Shoulders

■ Start of the Arm - Free Movement of the Arms

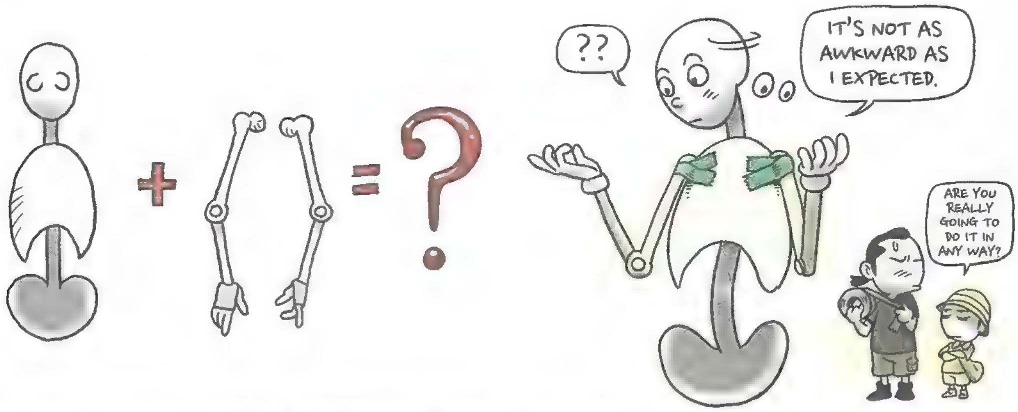
To better understand the arms, we need to know how the arm moves and where the arm starts. Basically, the anatomy of arms. Even if the arms allow various movements, it is useless if they are not supported by a fixture. So where are some movements of the 'arms?'



Normally, when we think of the role of the arms, we tend to think of extension and flexion first (bending and stretching exercises.) but as you can see in the picture above, the arms are three-dimensional and perform various movements. The arms could be called 'joint gift sets' because they have different joints to perform various tasks that the body and brain require. To sum, the arms are like our body's number one super assistant.

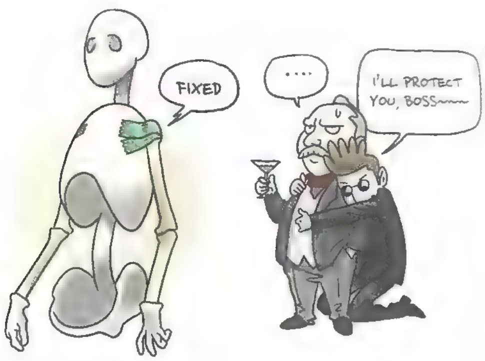


The question is then, where and how should we attach the 'number one assistant?' As always, let's just roughly attach it to the body in any way.

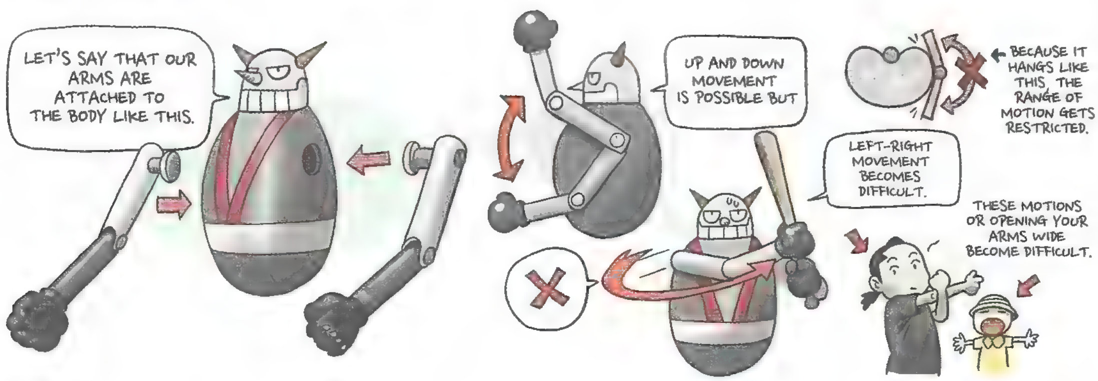


Hmm... yes, I tried attaching it anywhere I wanted. It doesn't seem to be a problem at first glance and to be frank, it would be so much easier if we could just attach the arms like this and move on to the next chapter. But, the thing is, this will result in two fundamental and fatal problems.

The first problem is that there's a restriction to range of motion. Our arms need freedom of movement in order to protect the body and to perform various functions. If the arms are attached to the body like this, that would be a serious problem.

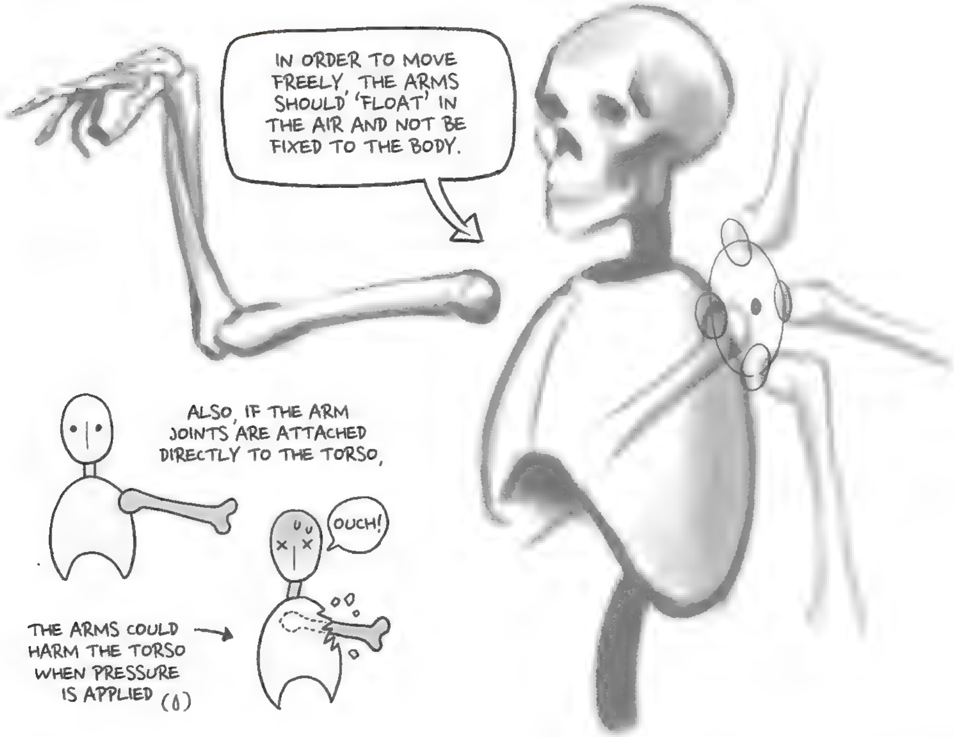


In the above picture, the thoracic cage where the arm needs to be attached is 'egg-shaped.' So, the linear arm wouldn't be able to stick. Even if the arms were somehow attached to the thoracic cage, they would not be able to move freely as shown on the picture on the right.
It would look like a cheap DIY robot.



The second problem is closely related to the 'thoracic cage' that we studied earlier. Do you still remember the fundamental function of the thoracic cage?

That's right. The fundamental function of the thoracic cage is to protect the life-supporting organs such as our heart and lungs.
But this protective cage moves frequently and if the starting point of our arms is directly attached to the trunk, the impact of the arms would go straight to the trunk since our arms take on various external stimuli. In this case, the arms that are supposed to protect the body might harm the body. Simply put, the arms could become a weapon which attacks the body.
This goes against the reason for the arms' existence, let alone its usefulness.

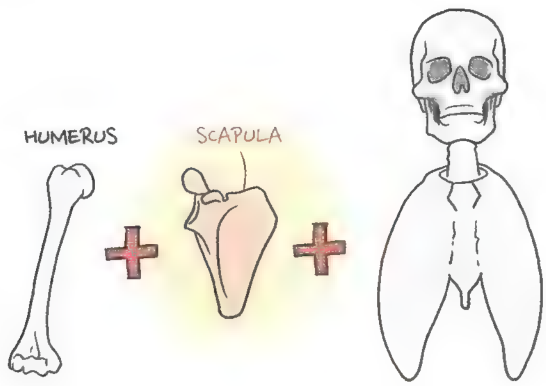


To conclude, in order move freely and at the same time to protect the body efficiently, our arms need to be somewhat 'separated' from our body. Is that easy to understand?

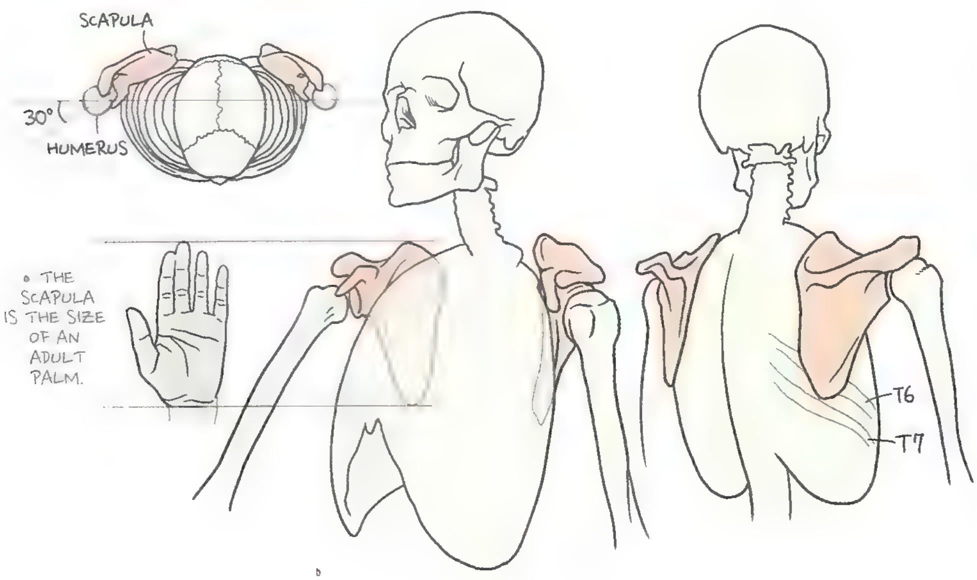
■Scapula, the Root of the Arms

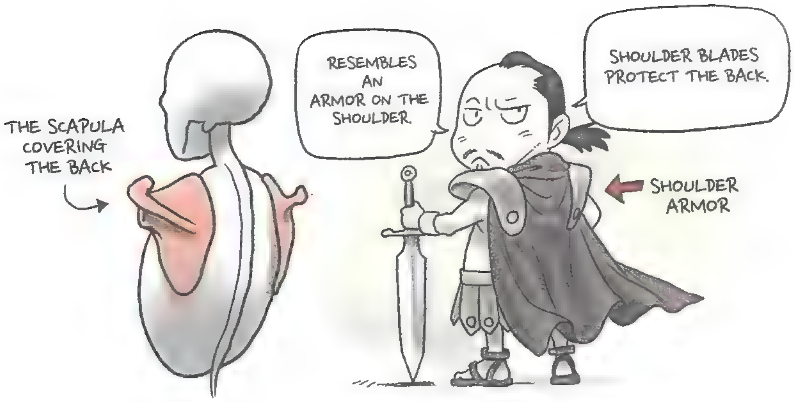
So, how does an arm hang from the body when it needs to be isolated? This is a difficult question indeed. The arms should be isolated from the body to move freely, but the arms should not be separated from the body. To resolve this contradiction, we need a special joint that connects the arms.

We call this joint the scapula.



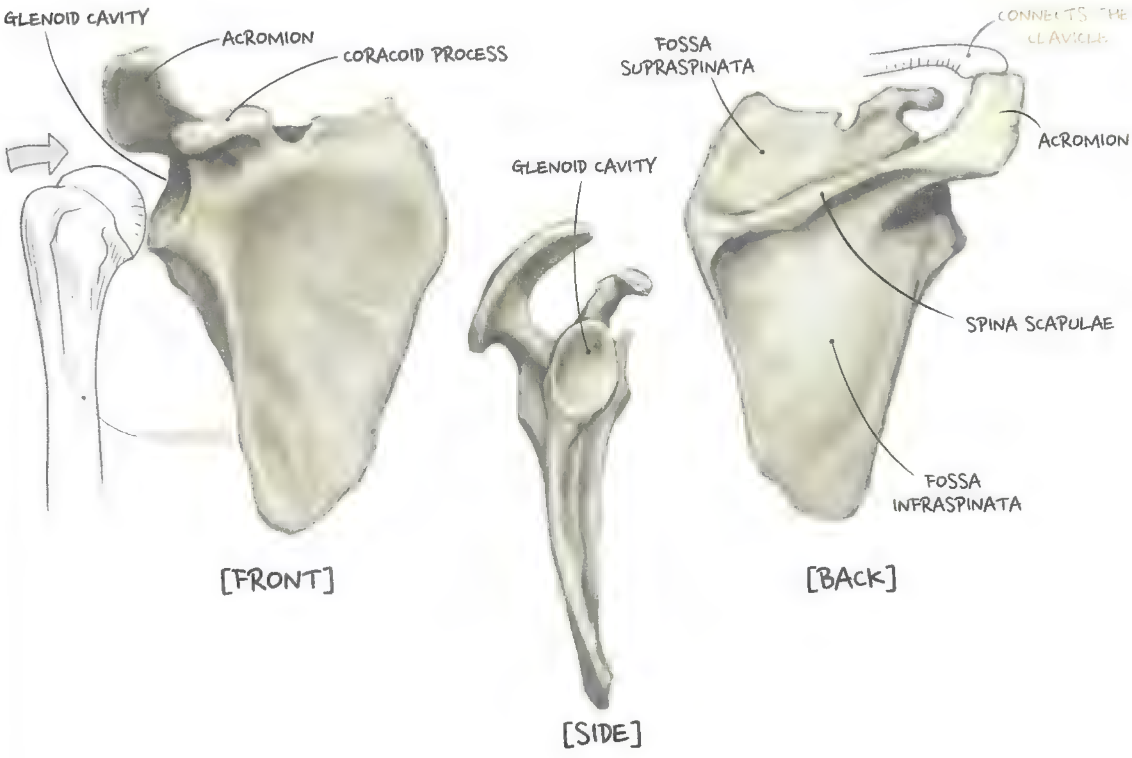
As shown in the following picture, the scapula, also known as shoulder blade, is the bone that obliquely covers the posterolateral aspect of the trunk and it is about the size of an adult palm. Due to its shape, in Chinese it was called 'armor of the shoulder' and in Latin it was called the 'scapula,' which means blade of a trowel.





Unlike its Chinese name of 'shoulder armor,' the scapula bone is very thin, but since it is surrounded by thick curves on its side and because it is attached to various muscles front and back, the scapula is well-suited to bear immense pressure transmitted from the arms.

First, let's take a look at some of the major parts of the scapula.
Please refer to the following page for detailed descriptions of each part.



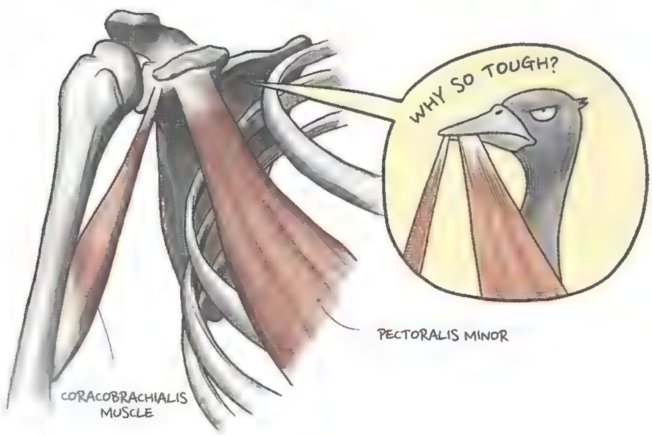
❶ Glenoid cavity

The glenoid cavity of the scapula articulates with the head of the humerus at the shoulder joint. Unlike the acetabular fossa (page 183) of the pelvis, the glenoid cavity has a shallow, pyriform articular surface like a dish, which enables the humerus joint to move freely. Occasionally, when there's sudden pressure, the humerus is dislocated from the glenoid cavity.

A 'dislocated shoulder' is when the humeral head gets dislocated from the glenoid cavity.

❷Acromion

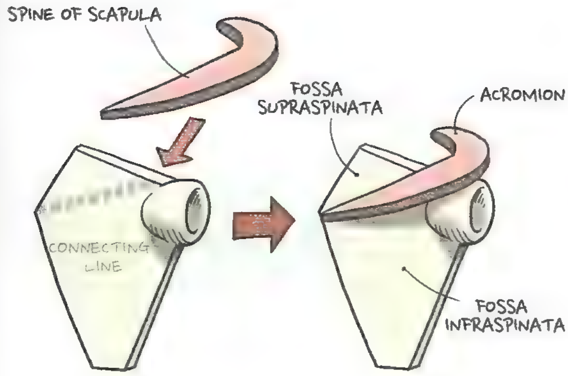
When the 'spine of scapula' at back of scapula turns forward, it becomes the acromion. It is the part of the scapula that joins the clavicle, which we will learn about next. Please refer to the next page to see what it looks like.



❸ Coracoid process

The name comes from the Greek word 'coracoid(raven)' because it looks like a raven's beak. It protrudes because it is the starting point for the many muscles that extend toward the arms and chest. The coracoid process appears often when studying the upper body muscle, so make sure to remember it.

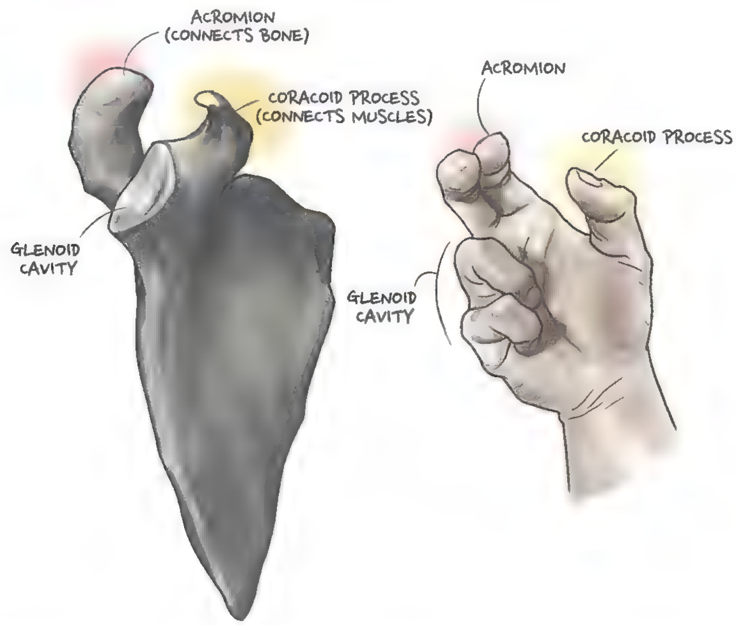
In addition to being the starting point of the coracobrachialis and pectoralis minor, the coracoid process is also the starting point of the caput breve of the biceps brachii.
Normally, when a bone protrudes like this, there's a good chance that at least two or more muscles begin here.



❹ Spine of scapula

If we look at the scapula from the back, the scapular spine is a prominent plate of bone. which crosses obliquely the medial four-fifths of the scapula at its upper part. Based on the boundary of this protrusion, the upper part is called the 'fossa supraspinata' and the lower part is known as the 'fossa infraspinata.' It is from this fossa that the muscles of the arms begin.

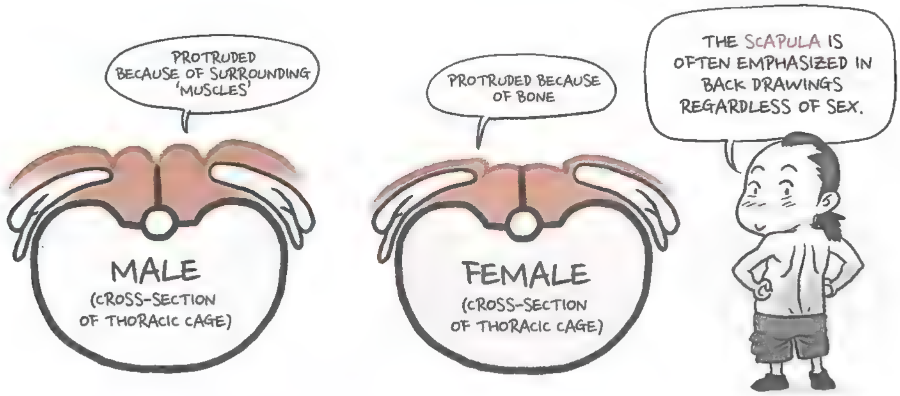
When I first studied anatomy, I often confused 'acromion' with 'coracoid process.' The 'acromion' is where the clavicle connects and the 'coracoid process' is where the muscles (coracobrachialis, pectoralis minor) start. When we study muscles, the coracoid process becomes an important reference point. Hence it would good to differentiate these two. If you are confused, try using your hands to remember them just like the 'hand pelvis' I shared earlier in this book.



There are other names to the various detailed curves, but this is all you need to know about the Scapula right now. The important point is that thanks to this broad-shaped bone, the arm can move freely despite its small axis.

■Observing the Scapula

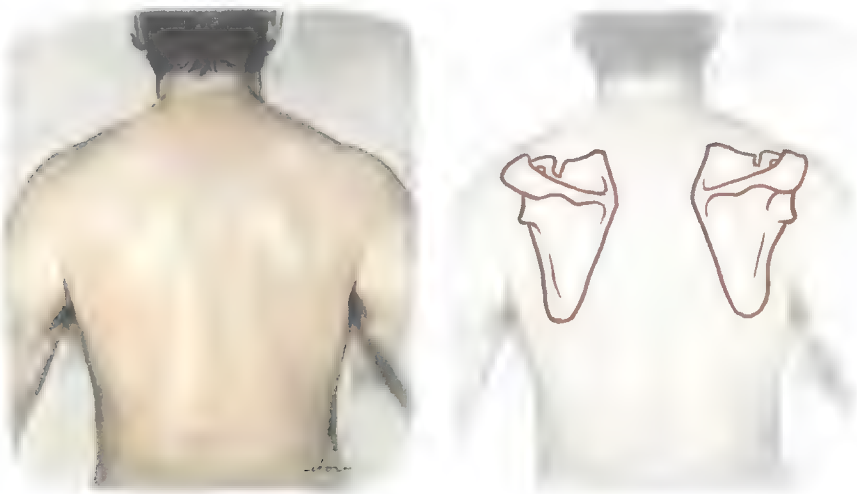
The scapula is obviously important both functionally, and anatomically. However, it also draws a lot of attention because it is visible on the surface of the body and can create 'expressions' of the chest and back. The scapula is more visible on women's back rather than on men who have more muscles on the upper body. The scapula is always depicted when drawing the back of women.



A study of male/female nude/2013: Although the shape of the scapula does not differ depending on gender, note that depending on the degree of muscle development that covers the scapula (erector spinae, trapezius) the medial border of the scapula and the spine of the scapula can either be depressed or protruded.

Above Is an example of a female's muscular back. Even though the scapula is covered by muscles, the inferior angle stretched outwards and medial border are clearly visible due to the movement of the arms.

Below: The back of an average man that we can observe at a swimming pool or sauna. It is difficult to spot the scapula due to high body fat but we can slightly see the protruded medial border of the scapula.



Imitation Drawing/2013: Boxers use a lot of movements such as punching that require arm and shoulders. Inevitably this leads to well-developed arm and shoulder muscles.

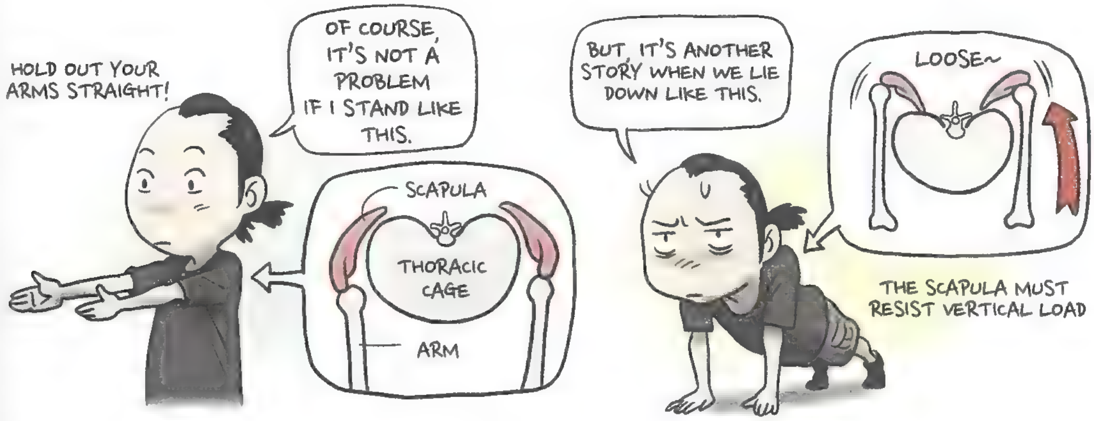
As mentioned before, the scapula is where the arm begins. The scapula works closely with muscles that enable the arms to function, so it is easier to observe the scapula in people whose job requires a lot of arm movement (athletes, construction site workers, etc).

These are the basic facts we need to know about the scapula, but let's not forget that the scapula exists to enable the free movement of the arm that is isolated from the body.
But this leads to another question.

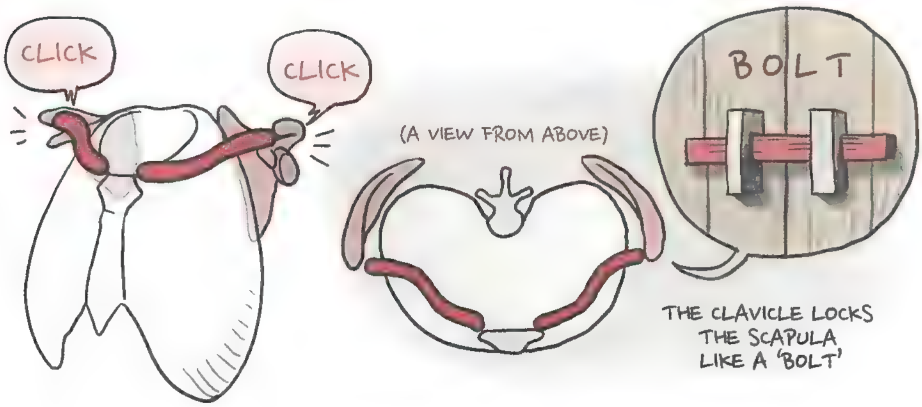
Which part of the body holds the scapula in place?

■Clavicle, the Lock for Scapula

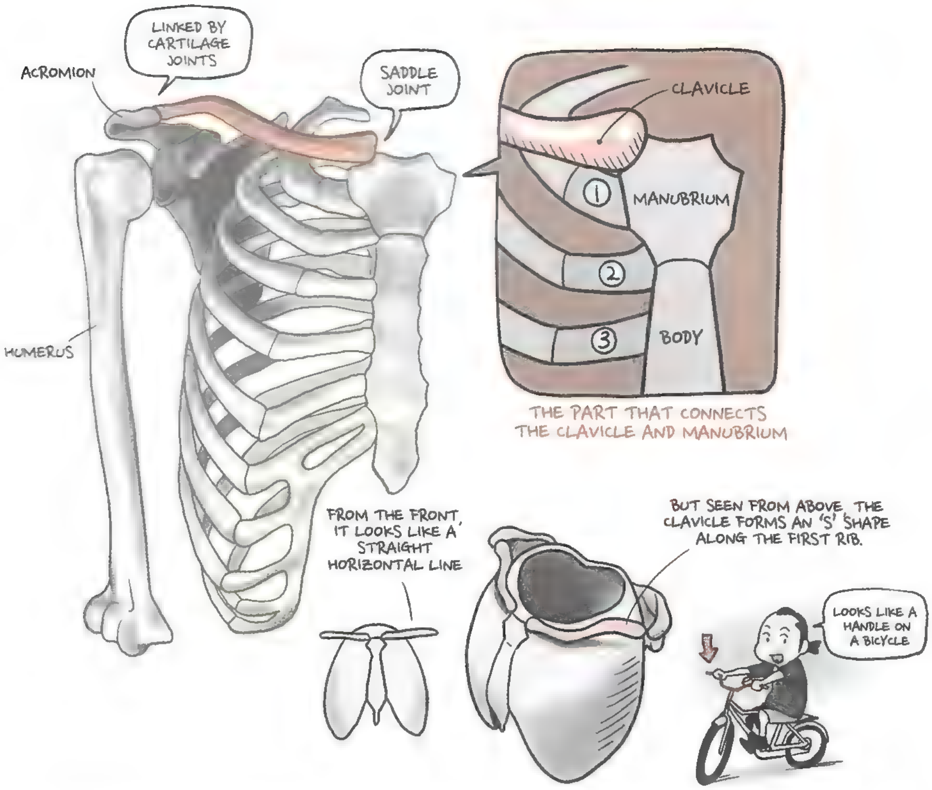
Because the scapula functions as a starting point for the arm and assists free movement, the scapula is the only bone that is not directly connected to the trunk of the body. In short, the scapula is a floating bone, and this allows the free movement of the arm. But it would also be a problem if the scapula was completely detached from the body.



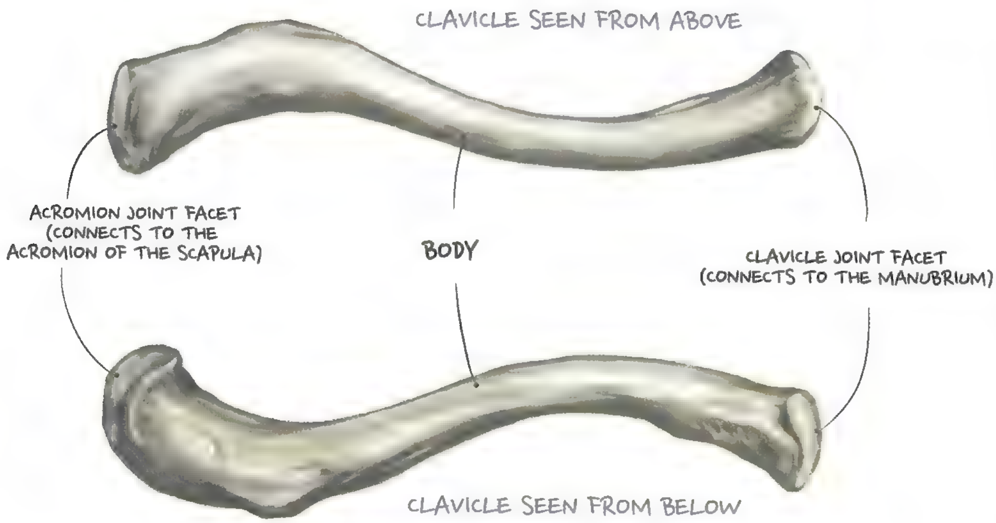
The scapula allows the arm to move freely, but at the same time, the scapula needs to bear the body weight and various loads that come from activities like jogging and sprinting. Thus, to prevent the scapula from moving too much, a 'lock' is required to hold the scapula in position. This job is done by the clavicle. In other words, the scapula remains locked in position thanks to the clavicle.



'Clavicle' in Latin means 'little key.'
Chinese is a direct translation of a "locking bone"



Because the clavicle is connected to the manubrium in the center of thoracic cage along with the 1st and 2nd rib, it can be mistakenly thought of as part of the rib cage. But the clavicle is different in shape, function and role from rib bones. Make sure to remember that the rib bone is considered part of the body trunk whereas the clavicle is categorized as a shoulder girdle along with the scapula.



Parts and names of the left clavicle

It is easy to overlook this bone because of its simple structure but the effect it has on our body is immense.

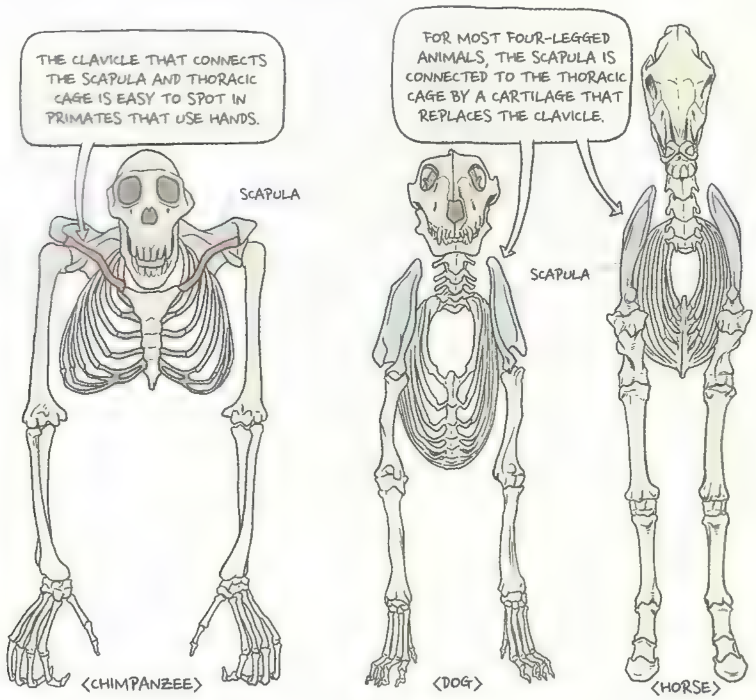
As mentioned briefly, the clavicle is connected to the manubrium and acromion and it limits the range of movement of the scapula. Interestingly, this is what enables the various movements of the arm. Ironically, the scapula being locked by the clavicle is what makes our arm movement more diverse and free.

'Free because of constraint.' As contradictory as this may sound, the function of the clavicle seems to teach the philosophy that 'there is more freedom when there is minimum constraint.'

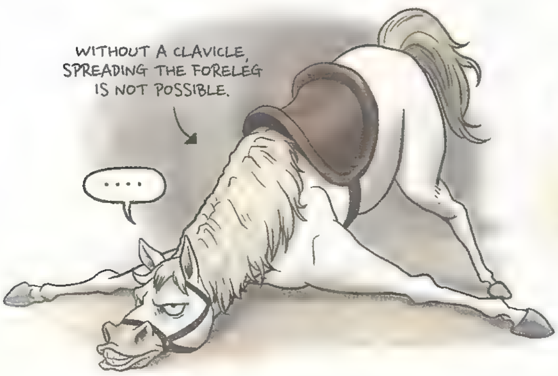
In sum, bipedalism gave us the freedom to use our arms for actions other than 'walking', and the 'clavicle' provides the minimum protection from the impact created by our various movements.

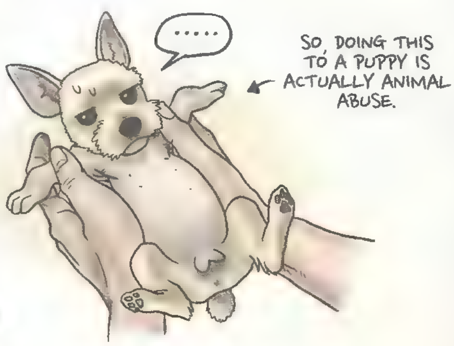
Wait! What about clavicles in Animals?

To understand the ironical statement that 'arms move more freely because their movement is restricted' let's look at four-legged animals. First, take a look at this picture.



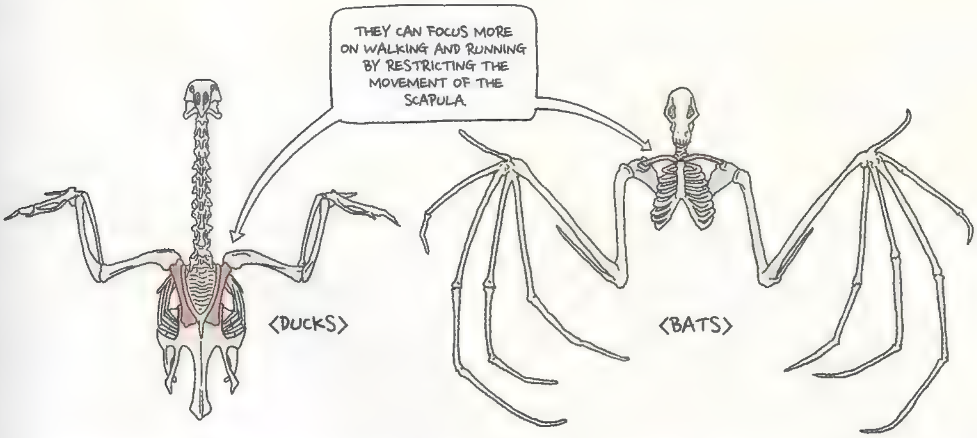
Excluding primates like humans, chimpanzees and orangutans that use hands for activities other than mobility, four-legged mammals such as dogs, horses and other animals either do not have clavicles or have atrophied clavicles. That is why their foreleg movement is simple. Because animals do not have clavicles that hold the scapula, the scapula itself needs to be fixed to various tendons and muscles around it. As the starting point of the foreleg is fixed, the animals' foreleg movement is limited to forward and backward movement.





The reason mammals do not have clavicles is not from a lack of evolution but because their forelegs are primarily used for 'mobility.' In other words, the animals' forelegs do not have other functions, and they have been optimized for mobility. There may be many reasons for this limitation but simply put, only having forward and backward movement is advantageous to four-legged animals.

In conclusion, mammals that use their foreleg as 'feet' do not need clavicles, but that does not mean that all animals other than primates do not have clavicles. Birds or bats that spread wings sideways also need clavicles.

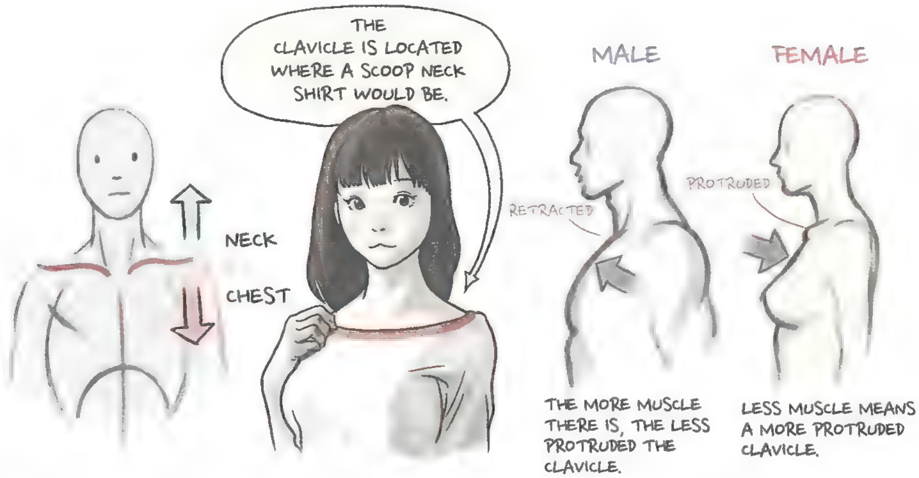


Also, clavicles can be found in animals that use their forelegs for hunting (rats, cats etc). From this we can infer that the clavicle is essential for diversifying the movement of the 'foreleg.'

Even though the clavicle is just one bone, without the clavicle, we would be unable to move our arms freely. The clavicle is a lock but at the same time it functions as a 'key' to arm movement. The term 'clavicle' is derived from the Latin word 'key' (clavis). In one way or another, the clavicle is an interesting and useful bone.

■Observing Clavicles

While the scapula is an important reference point for the back, the clavicle is a reference point for the front. Based on the clavicle line, above is the neck is and below I the chest. Women have more visible clavicles than men who have more muscle mass. Take a look at the picture below.



Similar to the scapula, the degree to which the clavicle is buried or protruded depends on how developed the surrounding muscles are (trapezius muscle, pectoral muscle, deltoid muscle etc).

There is a tendency to think of the clavicle as being symbolic of femininity and that is because women generally have less muscle groups developed surrounding the clavicle. When the muscle is less developed, the clavicle becomes more protruded and visible, making the neck look thinner and longer. This represents a 'frail and feminine' image that arouses the protective instinct.

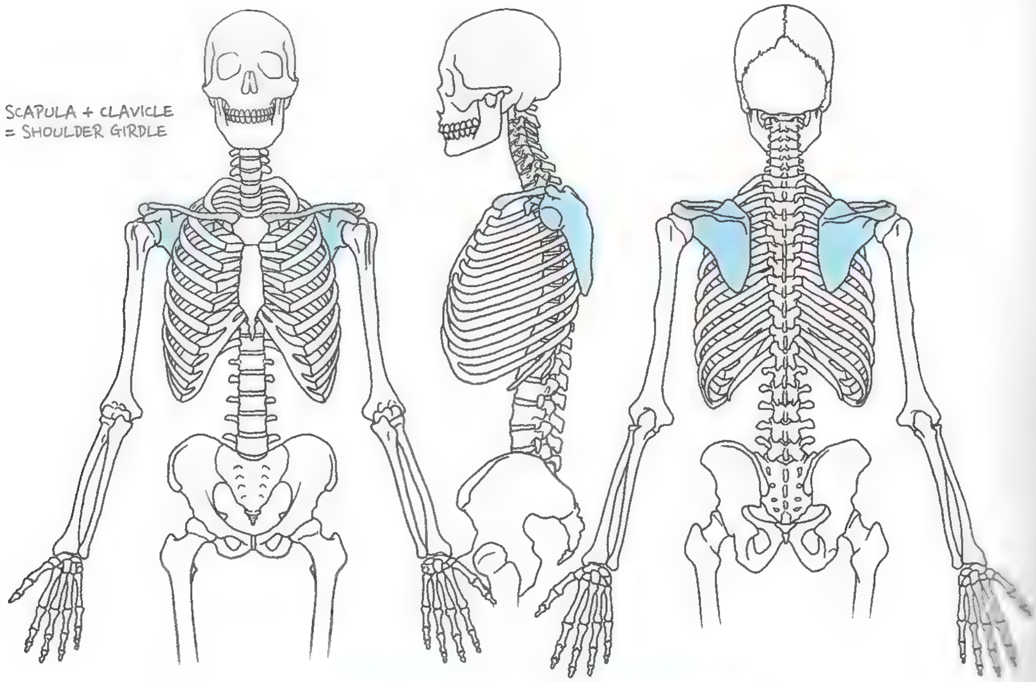
The clavicle is generally more visible in women, but we can also see clavicles on lean men. So how visible a clavicle is depends on how much body fat one has.

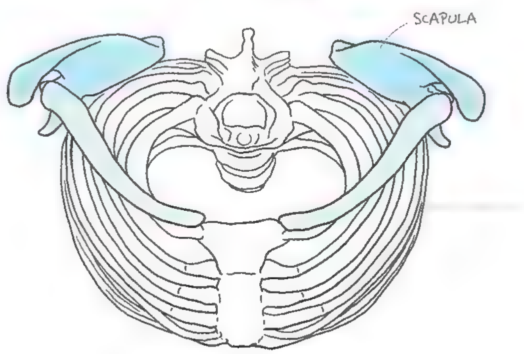
Lean men (left) also have very distinct clavicles. In the case of muscular men (right), we can tell where the clavicle is by observing the muscle attached to the lower clavicle (pectoral muscle and deltoid muscle).

In overweight and obese men, the clavicle gets buried underneath fat.

■Completion of Shoulder Girdle

We studied the clavicle and scapula structure that form the shoulder girdle. Without the shoulder girdle, the arms would not be able to function properly. Compare this to the pelvic girdle mentioned in the chapter on pelvis (page 176).





<'SHOULDER GIRDLE' SEEN FROM THE TOP>

If you have understood what I have explained so far, you are now ready to study the arm. To emphasize once again, the shoulder girdle is where the arm starts.

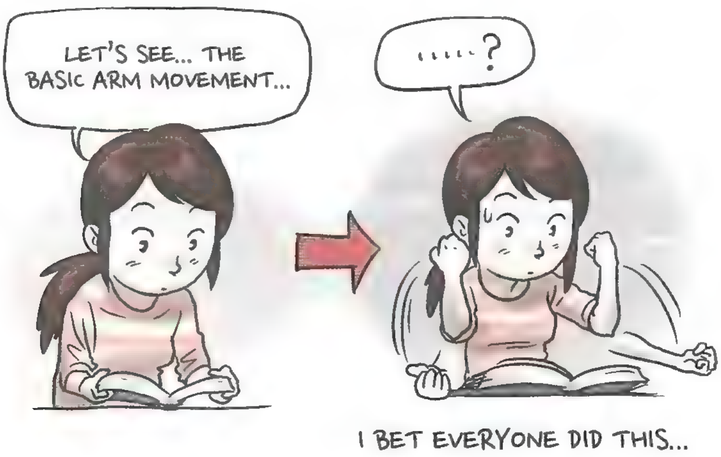
Therefore, *the shoulder girdle can change its shape and position depending on the arm* movement. We will talk more about the movement of the shoulder girdle after we take a look at the humerus.

Free Bones of Upper Limb, Flexion and Extension

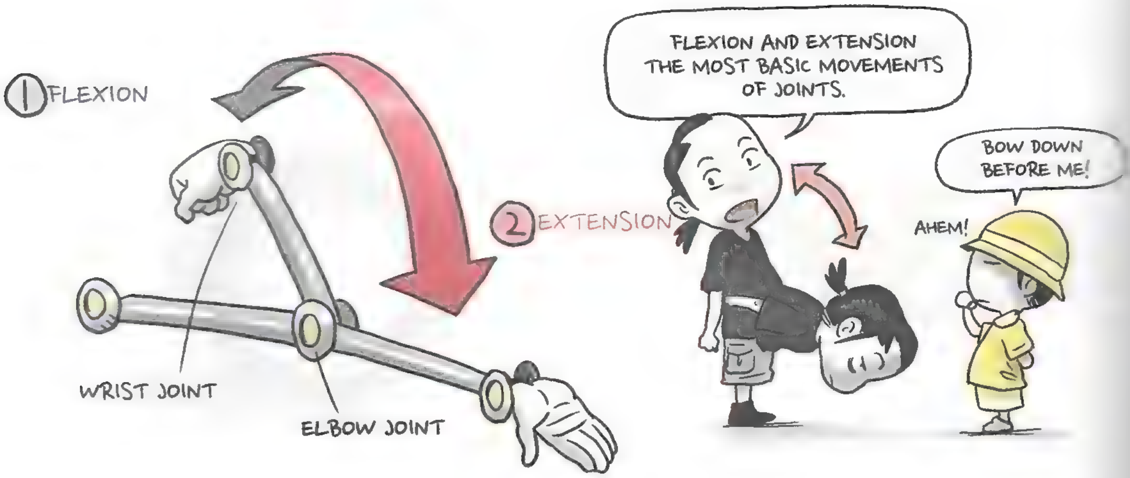
■What is a Free Bones of Upper Limb?

Since we have finished learning about the 'shoulder girdle' that holds our arm, it is time to look at the 'arm' itself. As mentioned before, the arm has many functions and its movement is very complicated. Because of this complexity, it is difficult to decide how to start learning about it.
In that case, it is always best to start from the basics.

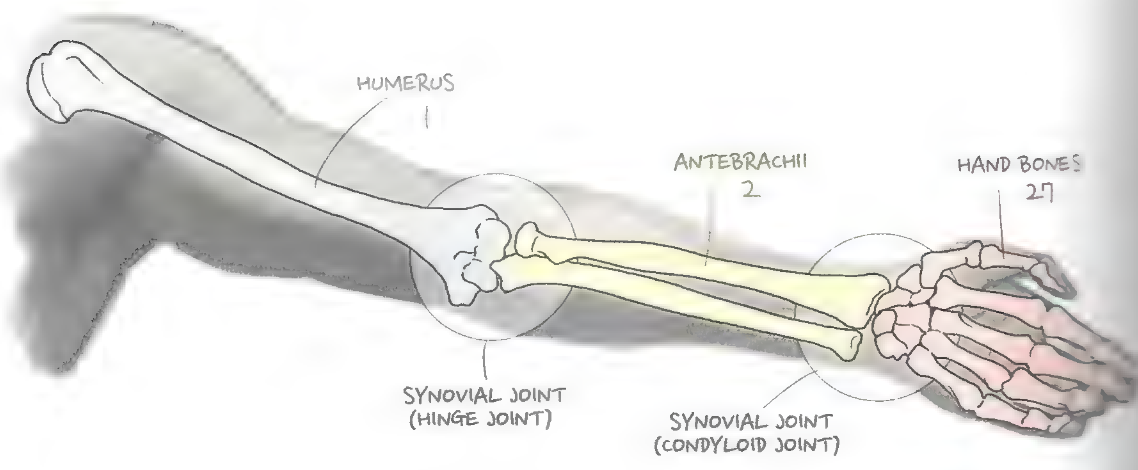
Let's begin by checking what we already know about the arm. Close this book for a moment and let's move our arms. What is the most basic arm movement?



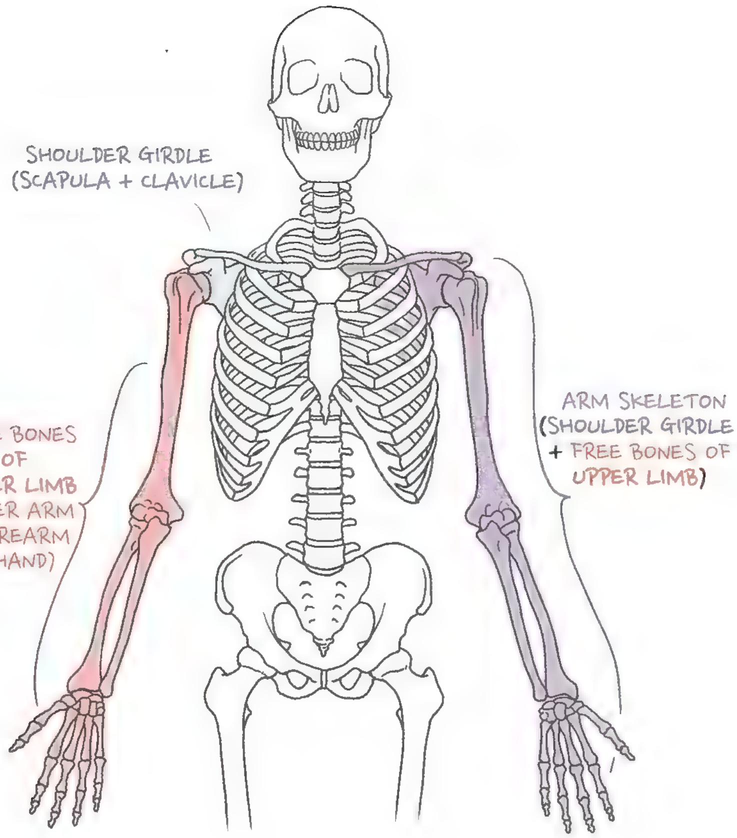
Many movements are possible with our arms. But I am sure the movement in the picture extend and flex is what comes to the mind first.



The arm can flex and because it mainly consists of 'synovial joints' (refer to page 48). Among the upper limb, flexion/extension most often occurs in the 'hand.' For now, we will look at the hand as one whole piece because the hand consists of many joints and we first need to understand the arm first. For now, let's say the arm is divided into three parts based on joints.



It is not marked in the picture, but the articulation between the scapula and humerus is a 'cotyloid joint.' The cotyloid joint has the greatest range of motion in human anatomy, but in order to avoid confusion, we are only going to talk about the 'free bones of upper limb.' Please refer to page 310 to learn more about the shoulder girdle and arm joints and movements.



We call this structure, (including the upper arm, forearm and hand) the free bones of the upper limb. Normally, people mistakenly think that 'arms' only consist of the free bones of the upper limb,
but to be precise, our arms include both the 'shoulder girdle' and 'free bones of the upper limb.' Let's try to remember that fact going forward.

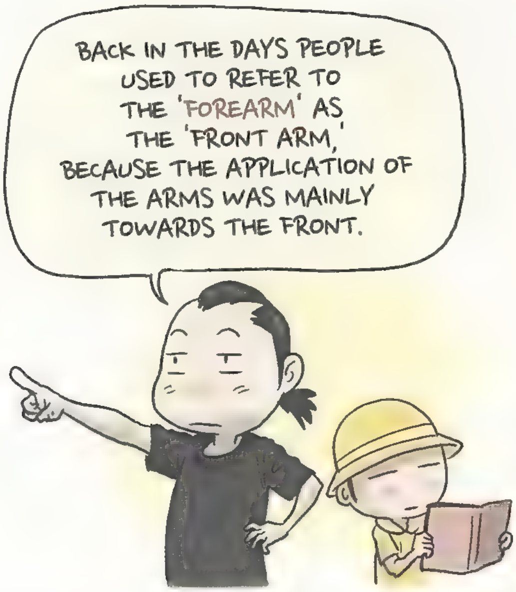
We will be looking at the details one by one later, so let's put aside the troublesome ones for now and learn the basic facts about the 'free bones of the upper limb' first.

> **1. The free bones of upper limb allow flexion and extension.**
> **2. The free bones of upper limb are divided into the upper arm, forearm and hand.**

It's simple, right? Based on these two facts, we can infer that the free bones of upper limb are divided into three parts to allow 'flexion/extension' movement. Even if your arm has a complex structure and does various movements, it all boils down to these simple facts. Therefore, please make sure to memorize the basics before you study each part of your arm

Wait! Lower arm? Forearm?

If we think about it, because the forearm is below the upper-arm, we should call it the 'lower' arm. If we look at the English term, it is called 'forearm.' For your reference, 'up-arm' is called upper-arm. I think the name forearm implies that more focus was given to the function of the 'hand' rather than the location of the bone.



Think about it; at work, we call someone based on their roles or positions (Manager Kim, Producer Choi) instead of their birthplace. The same reason applies here.

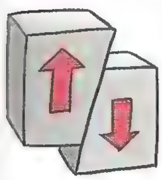
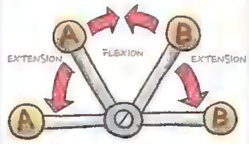
Joint Movement

We all know that the free bones of upper limb flex and extend. This is necessary for the following reasons.

The arm is specialized for 'movement' more than any other structure in the human anatomy. Since understanding the arm's movement is an important clue to understanding the arm's structure, but firstly, let's discuss the arm's movement.

'Arm bar' is a well-known offensive technique used in mixed martial arts that takes advantage of the fact that the arm skeleton's 'extension' movement is limited. Every mixed martial art 'joint lock' is based on this same principle.

First of all, most of our body movements are made by synovial joints. There are four major types of movements allowed by synovial joints (Please refer to page 49 for types of joints.)

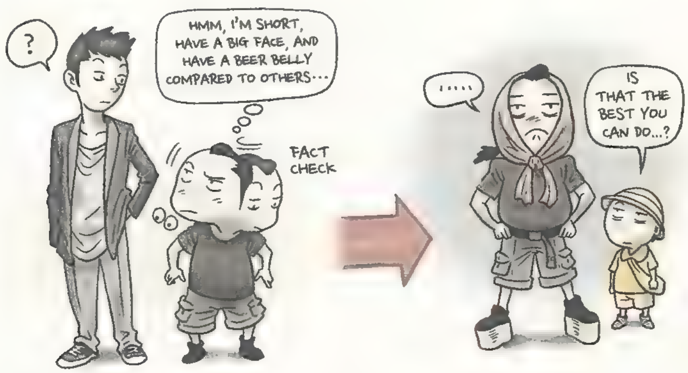
1. GLIDING MOVEMENT 	**1. Gliding movement** t is the most basic joint movement. Bones slide against each other along the flat surface. The movement is small. It is present in carpal joints and intermetatarsal joints.	2. ANGULAR MOVEMENT 	2.Angular movement This is the movement that comes to mind when we hear the word 'joint.' This movement is produced by changing the angle between 'A' and 'B' (decreasing angle is flexion and increasing angle is extension) starting from the anatomical position. Arm and leg exercises that use flexion/extension or abduction/ adduction all belongs to this movement. The movement is enabled by 'hinge joints.'
3. ROTATION MOVEMENT 	3.Rotation movement This movement occurs at the 'pivot joint.' two vertebra serves as the axis to allow rotation of C1. The forearms' pronation and supination movement are also rotation movements.	4. CIRCUMDUCTION MOVEMENT 	4.Circumduction movement This movement is similar to rotation movement but the range motion of circumduction is larger than that of rotation movement. Examples include the humerus connected to the shoulder joint and femur connected to the pelvic joint. The movement is enabled by a ball-and-socket joint.

Wait! Extremely commonsensical Studies

The chart makes the movements seem very special, but in reality these movements are a natural part of our daily lives.
Sometimes it might seem like scholars summarize and announce facts that we already know and make it sound as if they have made a major discovery, but their work is meaningful because they are defining a 'framework' from various ambiguous phenomena that occur in a complex structure – the human body.

*ACTUAL RESEARCH FINDING FROM SOUTH CAROLINA STATE UNIVERSITY MEDICAL SCHOOL (2012)

In other words, summarizing and learning the different types of joint movements will provide an important basis for understanding various movements of our body. Moreover, it is important to assess how humans can utilize their body compared to other animals. Then we can understand where humans stand in the ecosystem.



As animals living in packs, objectively assessing yourself is an important resource for survival.

To reiterate, these researches are conducted to 'establish the human identity.' If you have an assessment of your characteristic, you would be able to grow your strengths compensate your weaknesses. Consequently you will gain a competitive edge for survival. I don't need to mention that knowing the principles and structure of movement is helpful to those of you who draw.

Every movement mentioned above occurs because our arms have various joints. Among the different joint movements, the most intuitive movement is the angular movement that includes abduction/adduction and aforementioned flexion/extension.

At this point a curiosity arises. How much does the arm have to move in order to call the movement 'abduction' and 'adduction' or 'flexion' and 'extension?'

What I just did was to raise my arm and stretch it all the way. This can either become 'extending' or 'flexing' depending on the axis. As such, 'flexion'/'extension' and 'abduction'/'adduction' are concepts that are relative and therefore could cause confusion. That being said, there should be a 'standard plane' that defines the range of the angular movement. Please refer to pictures in the next page.

- **coronal plane**

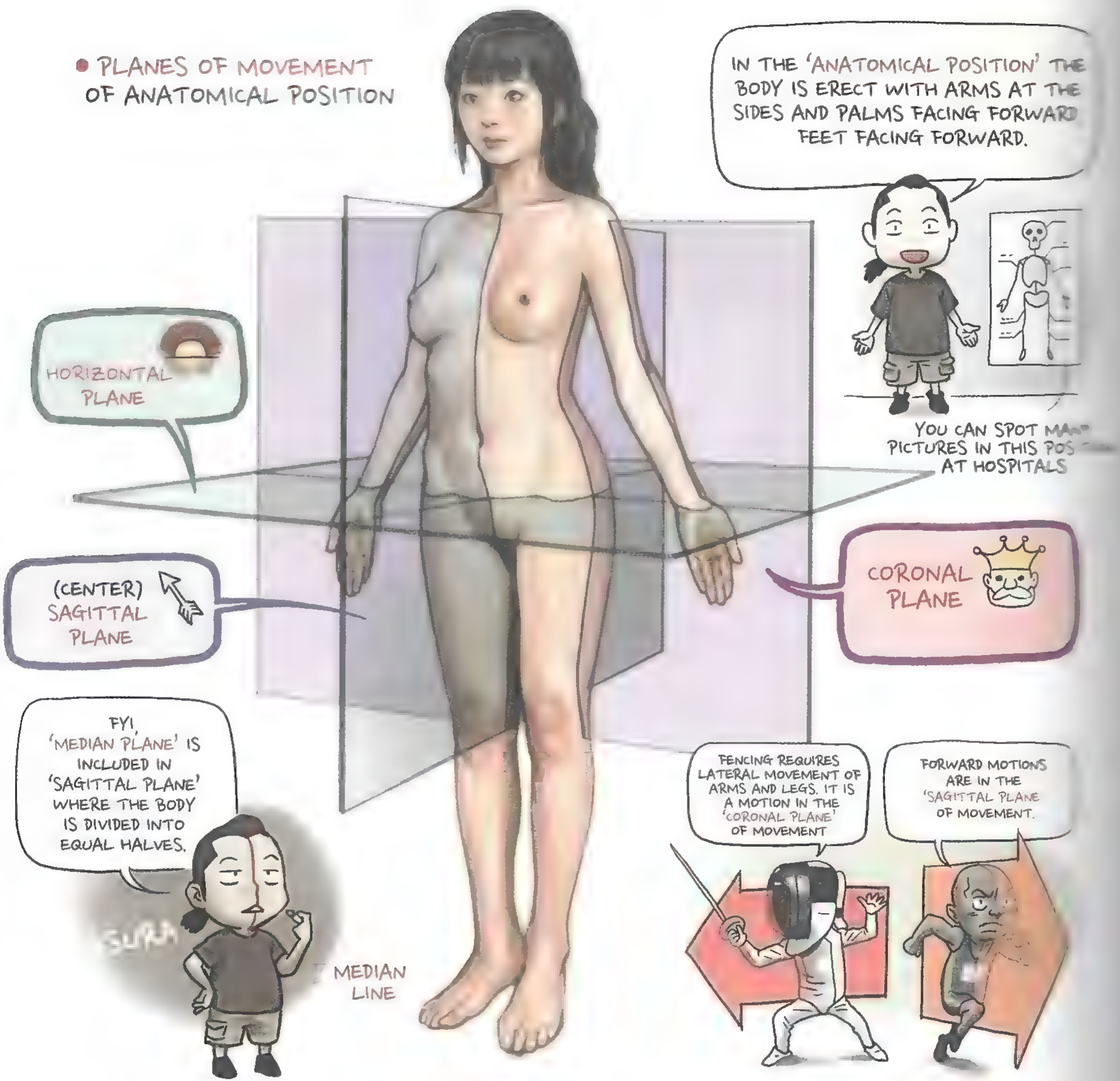
It is the plane seen from the front. The coronal plane divides the body into dorsal and ventral (front and back) portions. The coronal plane is the axis for 'flexion/extension.' 'Abduction/adduction' motions (fencing, windmill spin, lateral exercise etc) occur in parallel with the coronal plane.

- **sagittal plane**

'Sagittal' means 'like an arrow,' a reference to the position of the spine that naturally divides the body into equal halves—right and left. 'Midsagittal plane' is used to describe the sagittal plane as it bisects the body vertically through the midline, dividing the body exactly into left and right. The sagittal plane is the axis for 'abduction/adduction.' 'Flexion/extension' (hammering, running) motions occur in parallel with the sagittal plane.

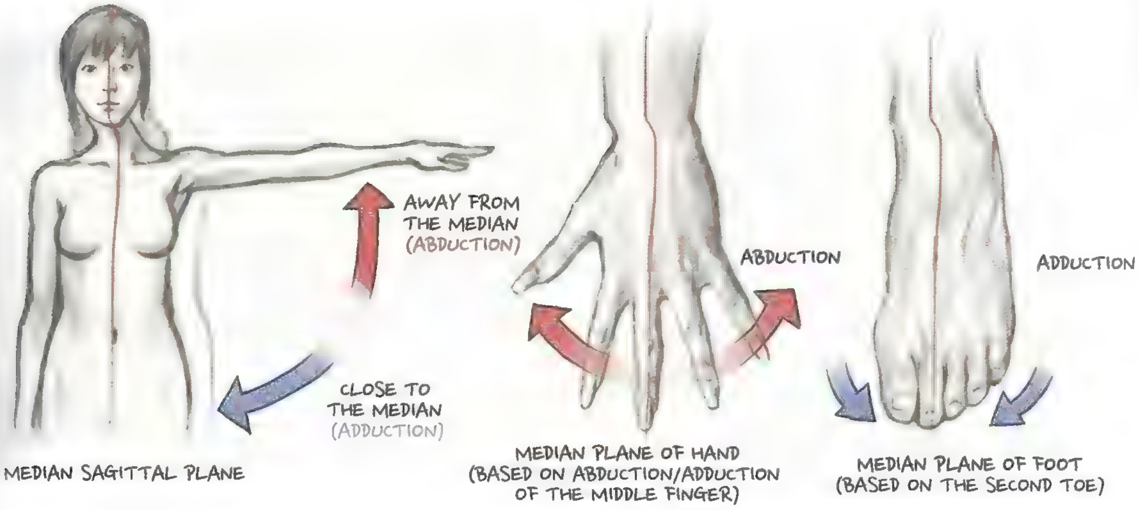
- **horizontal plane**

Think about a 'CT-scan' at the hospital that takes images of the cross-section of the body to understand the horizontal plane. This plane divides the body into superior and inferior parts horizontally. The forearm's horizontal motions made while playing tennis or table tennis occur along the horizontal plane.



The concepts of coronal, sagittal and horizontal planes are not only important bases for movement but also serve as important observation points in anatomy.

We might think that concepts such as the sagittal, coronal and horizontal planes are only usef when taking X-rays or CT-scans. We need to know these basic concepts in order to study the various movements of the human body. For instance, human limbs can move in any direction without these standards, it would be very difficult to define movements.



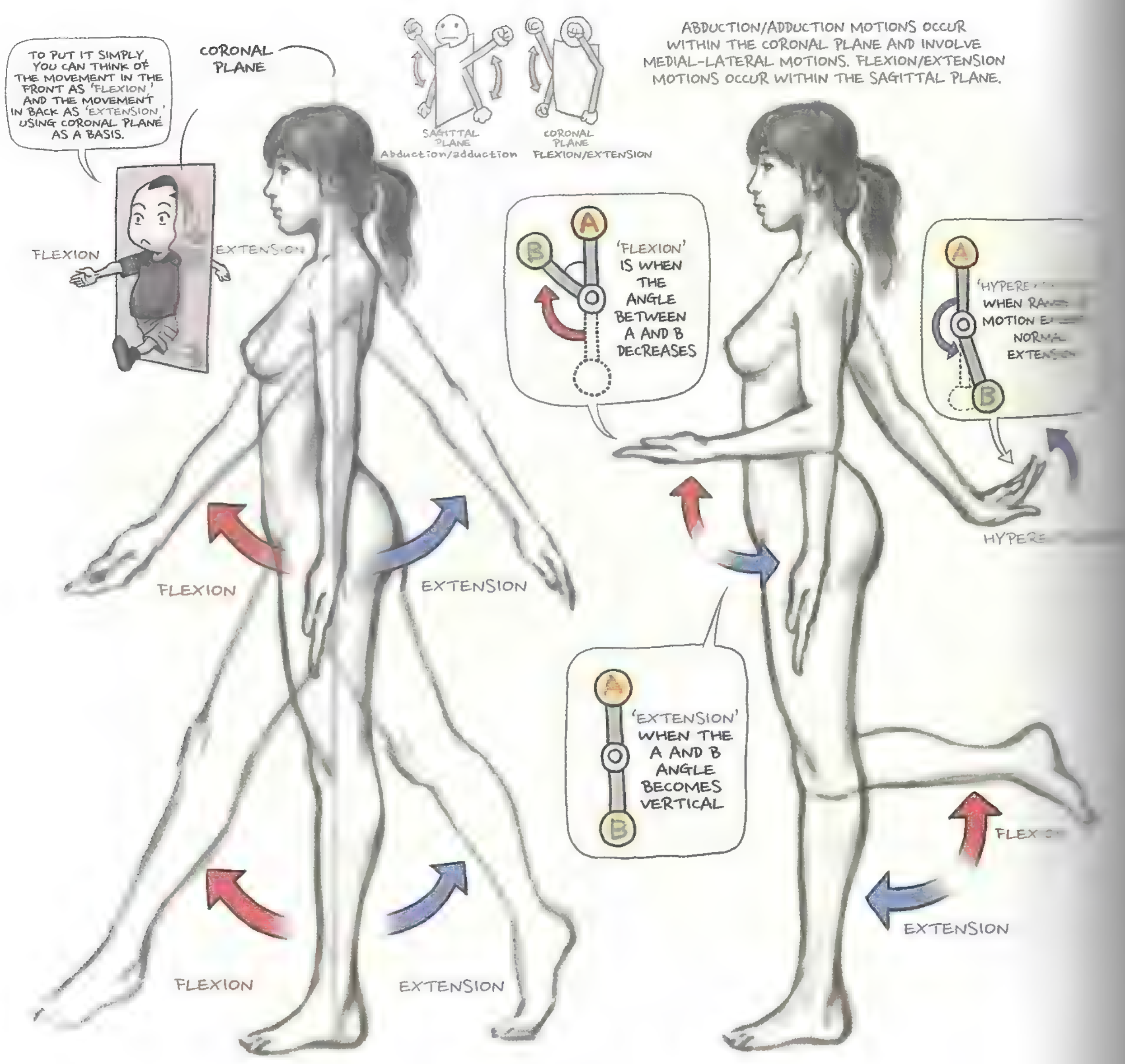
[The sagittal plane of hands and feet are different from the mid-sagittal plane that bisects the body in half.]

Unlike 'abduction/adduction' that can be clearly distinguished based on the median sagittal plane, flexion/extension is slightly different. By principle, based on the anatomical position, 'extension' is when our arms and legs are straight and 'flexion' is when the angle of joints decrease. But the same flexion movement can be defined differently depending on the axes such as whether you are flexing the whole arm or just the forearms, so it can get confusing.

Wait! Morphological, Physiological Flexion

As we have just seen, flexion motions based on the angle of joints are called morphological flexion. While morphological flexion is clear and intentional movement, there is another 'flexion' movement triggered by instinctive reflex to external stimuli. This is called 'physiological flexion.' Physiological flexion is similar to morphological flexion but the direction of flexion/extension for wrist and ankle are different.

[POSITION OF 'PHYSIOLOGICAL FLEXION']

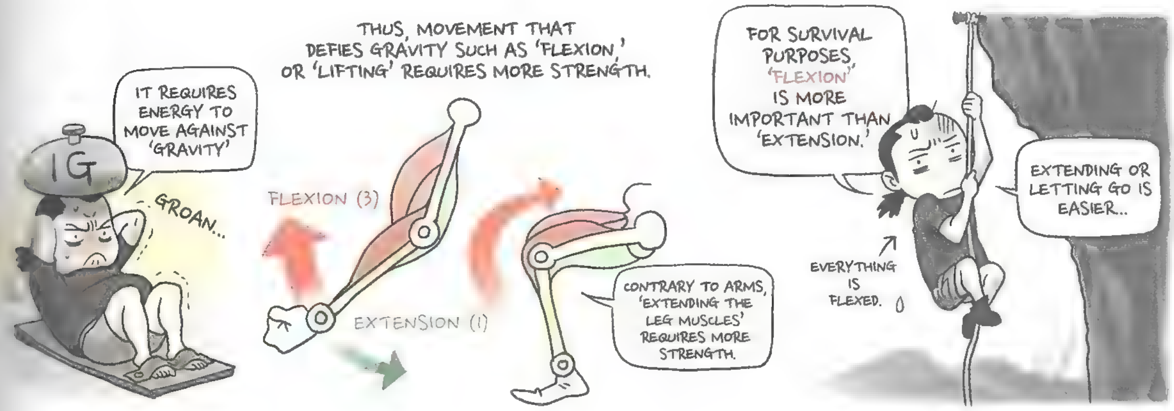


[For the upper arms and legs, forward movement is 'flexion' and backward movement is 'extension.' These movements take place within the sagittal plane.
However, for the lower arms and legs, we need to remember that the motions are not defined in relation to the coronal plane as axis, but based on the angle of the joint. 'Hyperextension' is excessive extension. Extending your fingers toward the back of the hand is a typical example.]

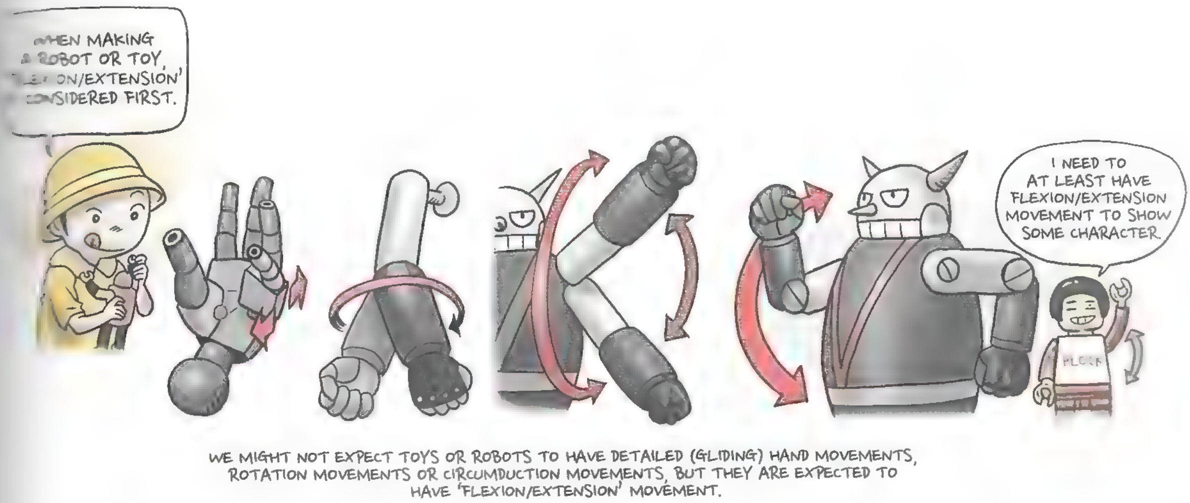
'Flexion/extension' movement may seem like a simple movement, but in addition to being used for walking or picking things up, it is also a 'survival behavior'. That we use to protect ourselves from unexpected external danger. We should not underestimate the importance of 'flexion/extension' movement.

'The Arm Bends Inward (Charity Begins at Home)'

Another evidence supports the fact that 'flexion/extension' is related to survival. In short, 'flexion/extension' movement is not an optional movement but an essential movement for humans living on Earth. Why? 'Flexion/extension' movement defies 'gravity.' Terrestrial animals cannot move unless they overcome gravity and not being able to move means 'death.'

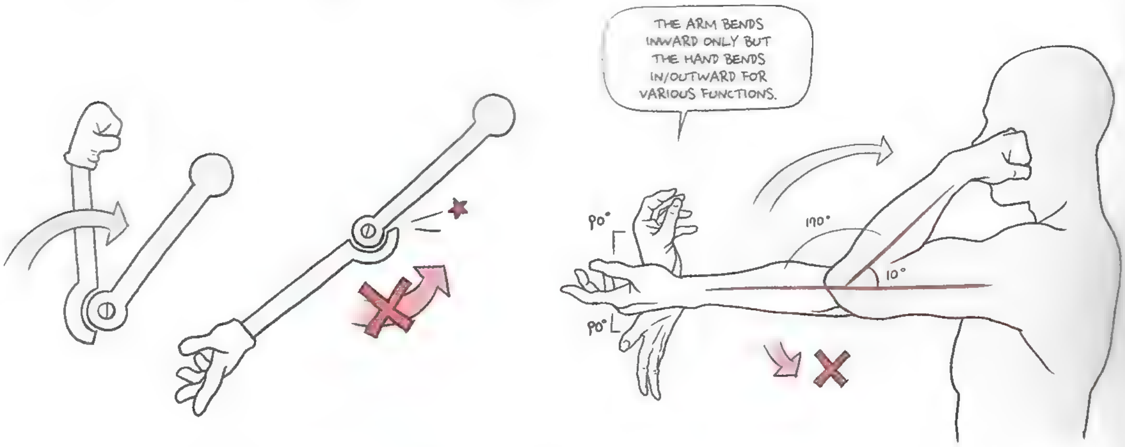


While other joint movements (gliding, angular, rotation, circumduction) are also important, the angular motion is essential in relation to survival. That is why the arm, a part of the body that consists of a collection of 'flexion/extension' movements are so important.



For your reference, more movement means that more natural positions are possible. This drives up the price of the plastic model or toy.

As such, 'flexion/extension' is a movement that represents the most fundamental characteristic of our arm's structure. That is why the word 'flexion (bending)' comes to mind when we think of the word 'arm.' There is a Korean idiom that says that 'the arm bends inward.' As the idiom implies, the arm bends inward, and not outward.

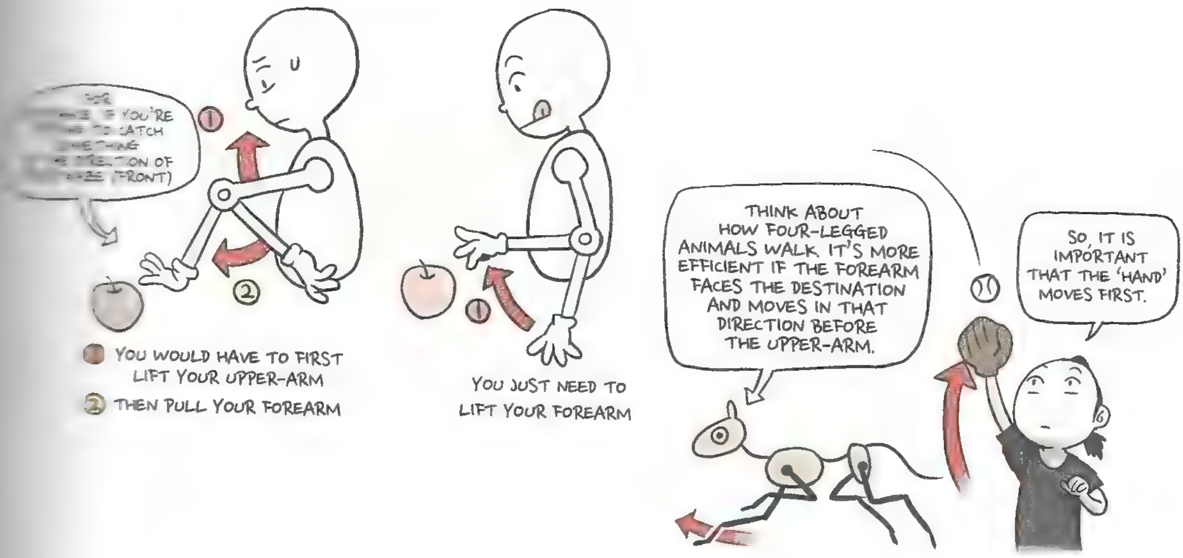


The arm might bend inward but remember that the wrist can bend both in/outward.
By principle, bending the wrist backward to the forearm should be called 'hyperextension,' but for convenience, we call this movement 'dorsal flexion.' The palm bending toward the inner forearm is called 'palmar flexion.'

It is common sense that the arm bends inward. Even a three year-old knows this, but why does it bend inward? Wouldn't it be better if the arm bends outward too?

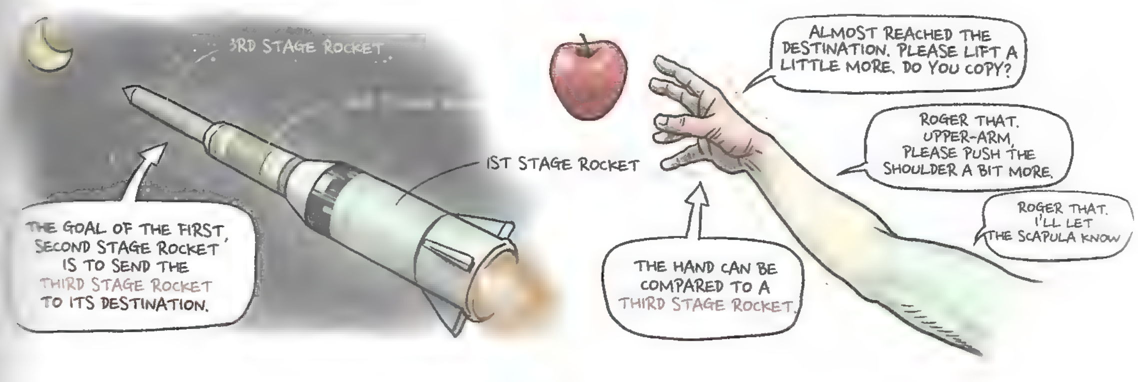
At first, it might seem more convenient if the arm could bend outward too, but this would require double the strength on both sides of the arm to lift the hand against gravity.
This would make the arm mechanically inefficient. Moreover, there's a fundamental reason behind why the arm bends inward only.

IF THE ARM BENDS OUTWARD,
THERE WOULD BE FUNCTIONAL PROBLEMS.



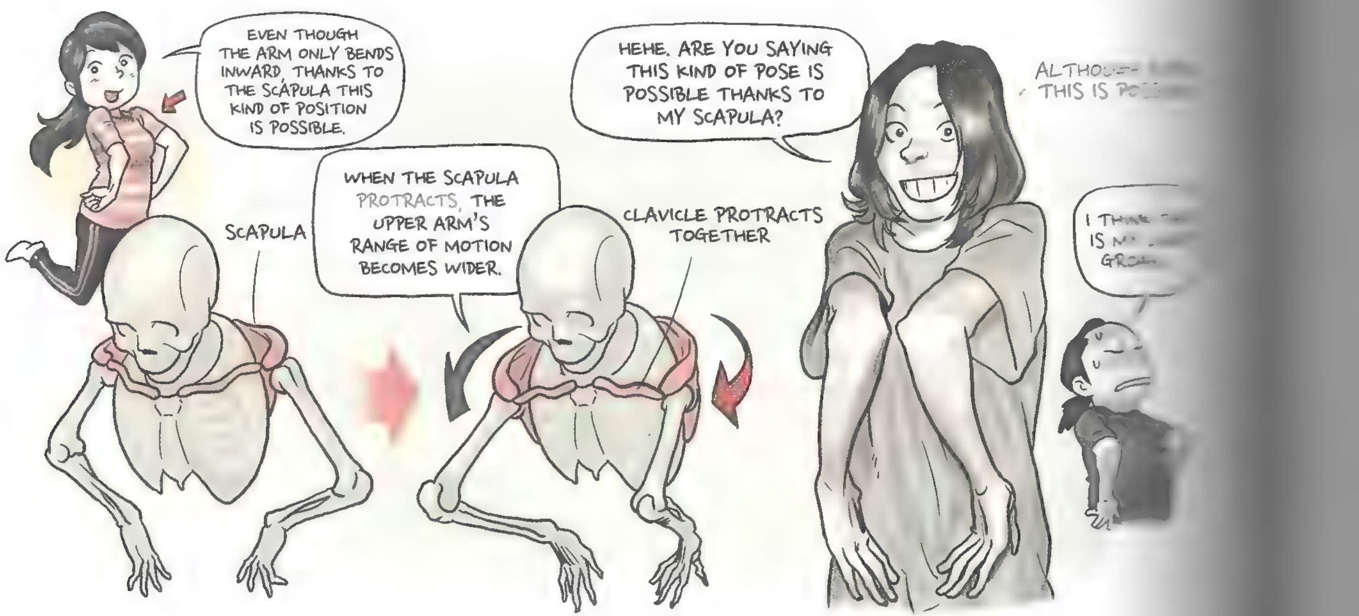
Whether it is for eating, moving or dealing with external stimuli, it is the 'hand' that needs to move first for our survival. In other words, it is more efficient for the arm to follow the hand rather than vice versa.

In sum, the arm serves as a supplementary structure that assists the hand to move.



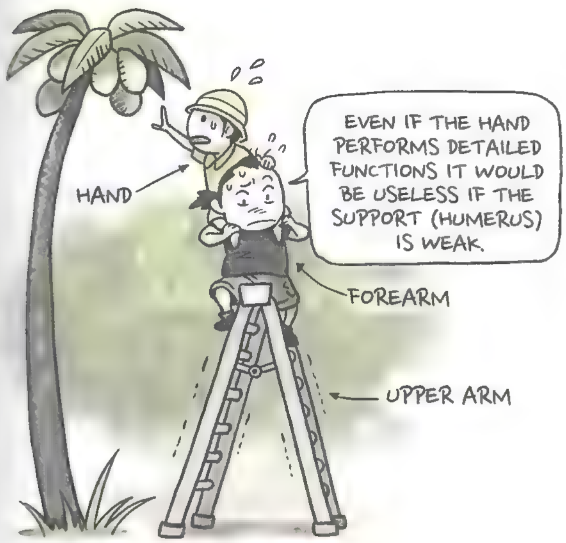
Lastly, even though the arm bends inward, because the arm is not directly connected to the thoracic cage, it can bend in different directions with the help of the scapula and shoulder joint (glenoid cavity) as they have relatively free movement. If needed, you can even pose your arms so that it looks like they are bent outward (refer to the picture on the right).

The body can make various movements as it is made up of different bones and joints, but it is the arm that shows the joint movements most directly and explicitly. Understanding movements is extremely important not just for medical purposes but also for art. For example, the fine arts and dance use various expressions of the human body.



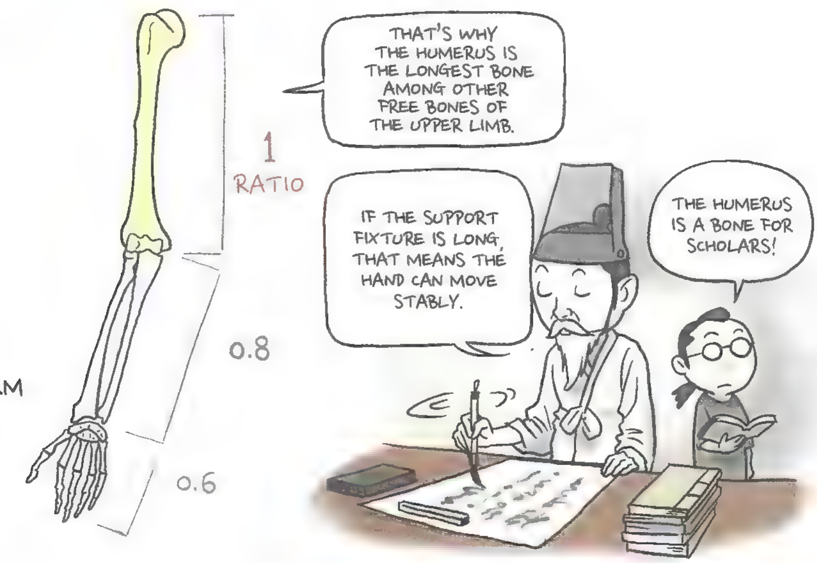
Moving the Arms Up and Down

Humerus, a Stable Support Fixture of the Arm



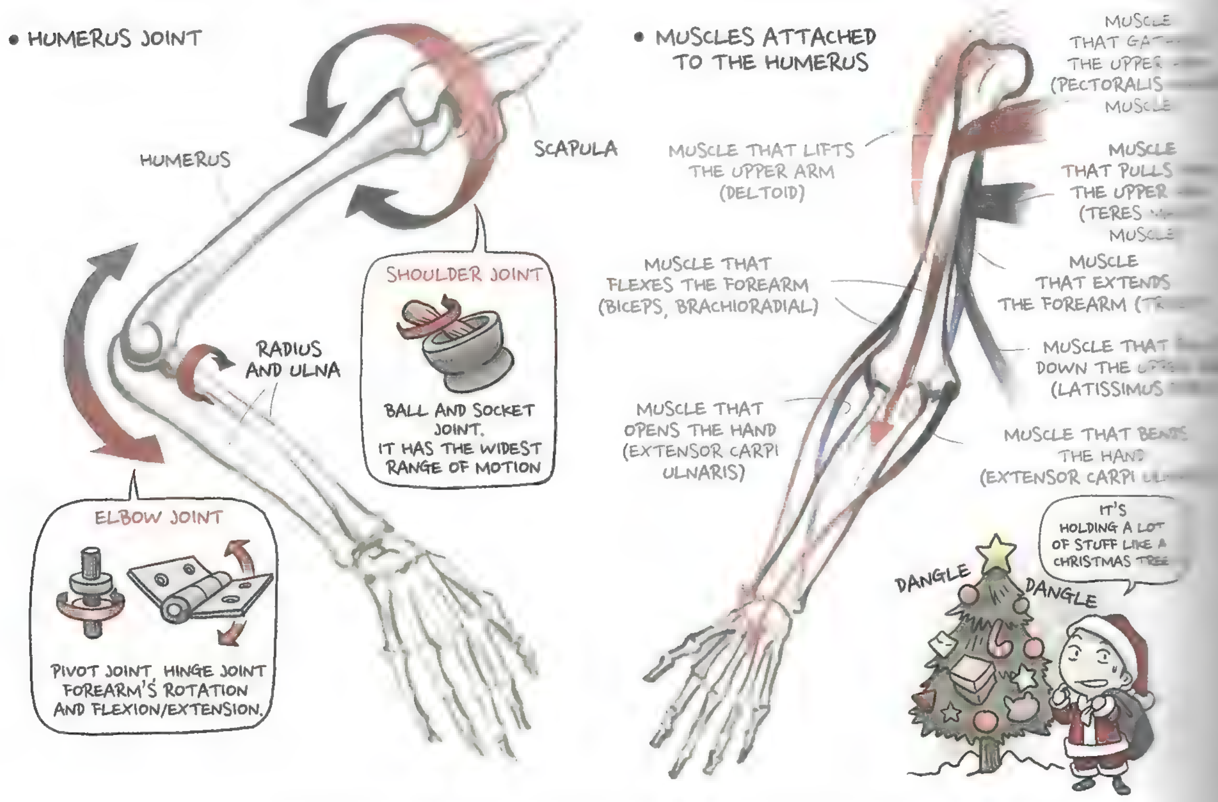
Let's take a closer look at each bone in the free bones of the upper limb that allows various movements. We will first look at the humerus which is made of a single bone. The humerus is the long bone in the upper arm and it is the biggest bone in the arm. It is distant from the hand, but it serves as a stable support. As a result, it is a bone that affects the detailed movement of the hand.

I will explain further later on, but the arm is categorized as 'class three lever (refer to pg. 480).' Therefore, the longer the humerus, the more stable and takes less effort to raise the arm in the air and perform activities such as calligraphy or conducting.



In physiognomy, the humerus is considered 'the lord,' and the forearm as the 'servant.' Very rarely there are cases where the forearm is longer than the humerus. In those cases the arms are suited for brute strength more than writing, so in physiognomic sense they are considered to be warriors in good terms, and barbarians trying to overthrow their leader in bad terms. Pay close attention to the arms of villainous characters who are either strong or agile

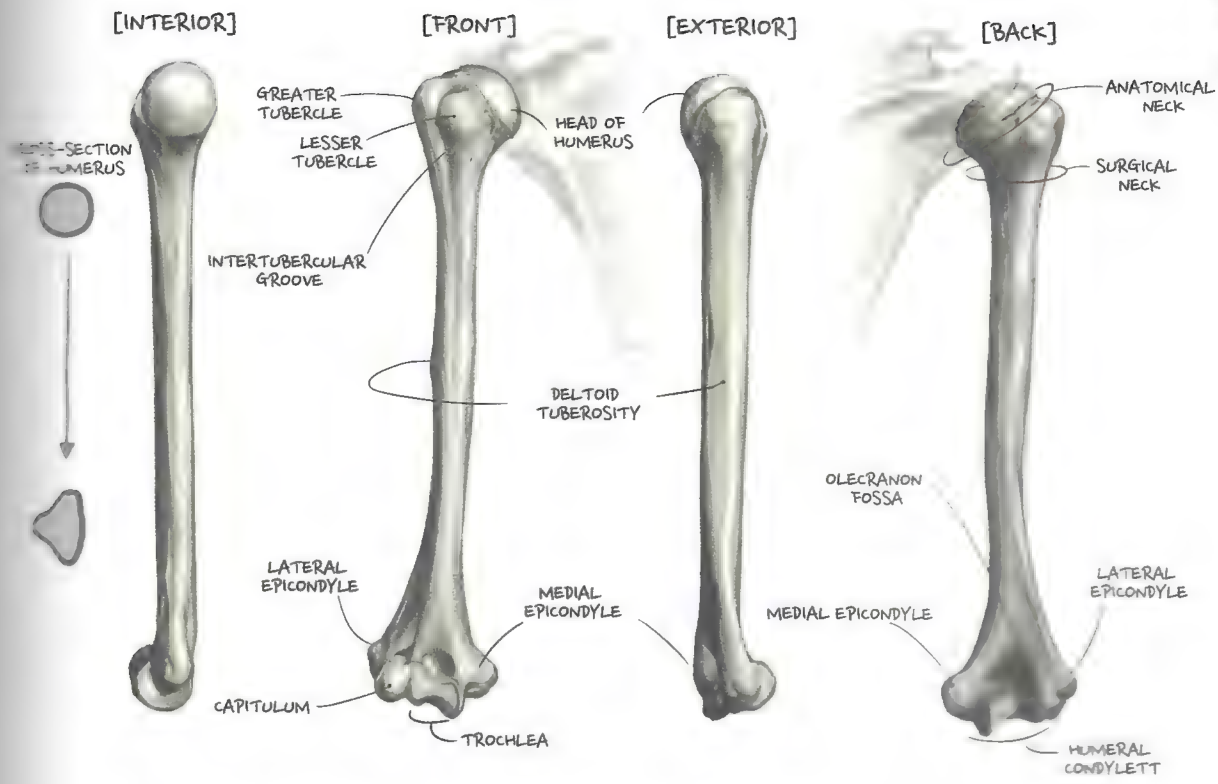
Even though the humerus looks simplistic, the upper part of the humerus is in charge of connecting the arm to the body and the lower part takes care of the forearm's movement. The lower part is also the origin point for the muscles that control hand movements. Thus, it is important to closely observe the humerus.



[Both shoulder and elbow joints are synovial joints. The shoulder joint is a simple joint with two articulated bones, whereas the elbow joint is a compound joint with two or more bones.]

❶ Figures and Names of the Humerus

The humerus is where various movements of our arm and upper body start. Therefore, it is important to take a close look at the names of each part before moving onto the movement of the humerus. The following picture is the upper arm or the humerus that is the axis of the arm. You can see the figure of the humerus from four directions, each 90-degrees apart, starting from the inner side.



Based on the above picture, the humerus structure will be described in the order of top to bottom

1. **Head of humerus:** The head articulates with the glenoid cavity of the scapula to lead the overall movement of the free bone of the upper limb. It is nearly hemispherical in form.

2. **Anatomical neck:** The anatomical neck of the humerus has a slightly different shape as if the humerus has a cap on it. The narrow boundary directly below is called the 'neck' anatomically.

3. **Greater/Lesser tubercle:** It is the large and small protrusions that form a 'furrow' just below the humerus. The furrows that form between these tubercles are called 'intertubercular grooves' and the long biceps tendon passes these furrows. (refer to page 354).

4. **Surgical neck:** While the anatomical neck defines the 'neck' anatomically, the surgical neck got its name because this part is easily fractured and often needs surgery. The 'neck' serves as a boundary between the head and body, so below the 'neck' is the 'body of the humerus.'

5. **Deltoid tuberosity:** The deltoid tuberosity is a rough, triangular area (V-shaped) on the anterolateral surface that takes up the upper half of the humerus. The area is rough like velcro because the lower part of the deltoid muscle needs to be attached to the flat humerus.

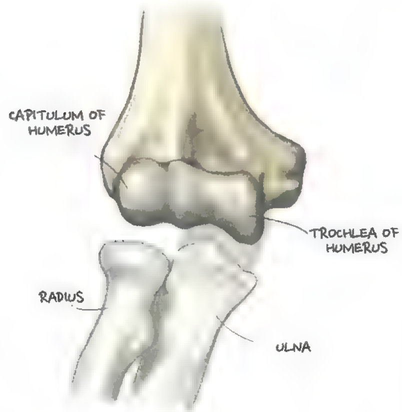
6. **Lateral epicondyle:** The lateral epicondyle of the humerus is the protruding part of the lower outer part of the humerus. It is protruded because the tendons of the muscles that stretch or bend the hand need to be attached.

❼ **Medial epicondyle:** If the lateral epicondyle is a protrusion for opening the hand, the medial epicondyle is the starting point of muscles that flex the hand. As I explained earlier, flexing your hand is harder than extending your hand and requires more strength. So, the medial epicondyle is slightly more prominent because it holds the muscle in charge of flexing the hand. You can feel it by touching the inner side of the elbow (try finding it!).

❽ **Capitulum of humerus:** It articulates with the head of the radius that rotates the forearm. It is where the rotation of the radius starts, so it has the shape of a round ball.

❾ **Trochlea of humerus:** The humeral trochlea articulates with the head of ulna that flexes/extends the forearm. It has the shape of a bobbin.

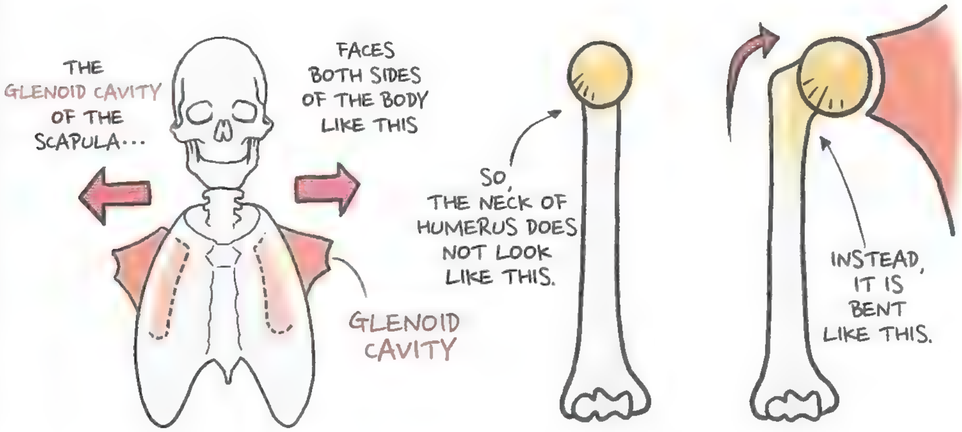
❿ **Olecranon fossa:** The olecranon fossa is on the posterior side of the humerus. It is a depression that prevents the olecranon (page 325) of the head of ulna from bending backward.



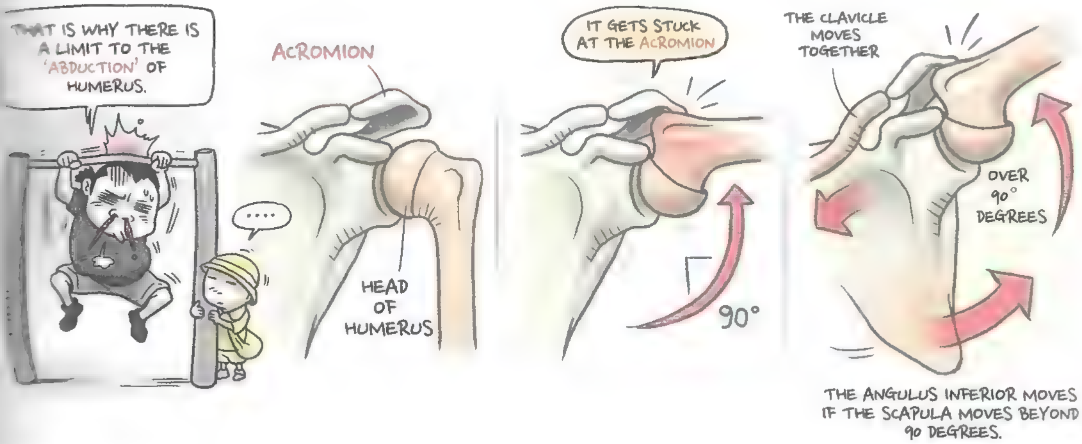
⓫ **Humeral condyle:** The humeral condyle is also situated on the posterior side of the humerus. It articulates with the head of forearm.

❷ Movement of the Humerus

One thing to note about the shape of the humerus is that it is more like the alphabet 'r' than number '1' to connect with the scapula. Same goes for 'femur,' which is the humerus for legs – refer to page 463.

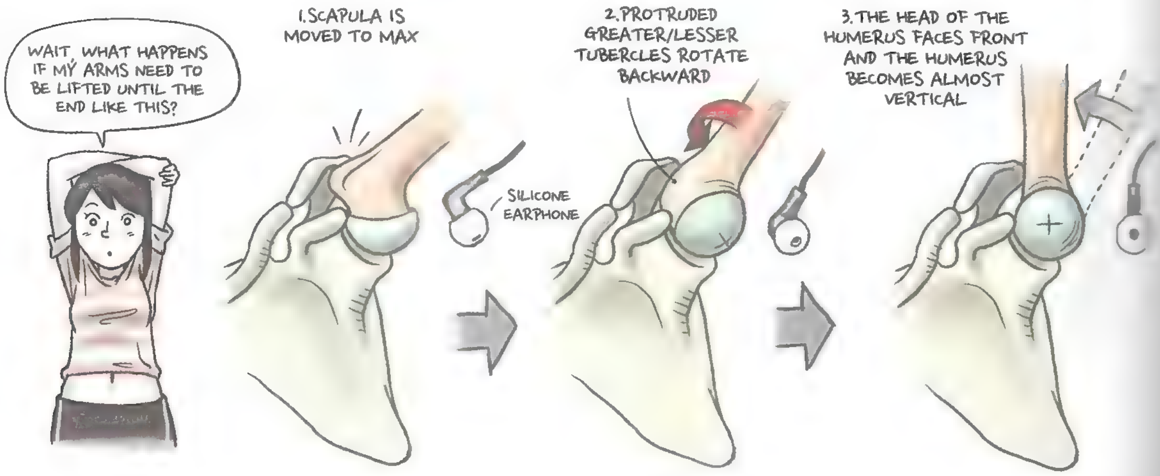


The 'surgical neck of humerus' is bent toward the glenoid cavity to maximize the contact surface between the head of humerus and the glenoid cavity. Ultimately this is to provide stable movement. But of course, problems always arise where they are least expected.



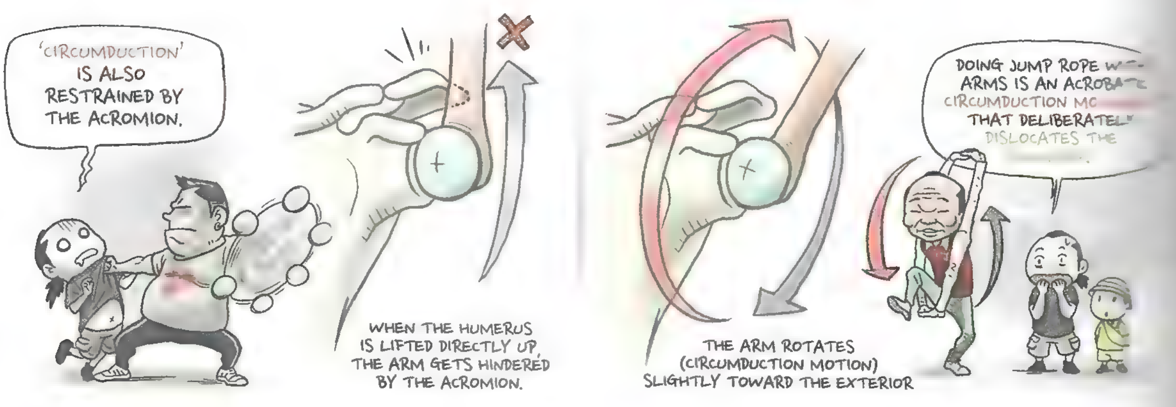
This means that the scapula that is supposed to allow free movement of the humerus is hindering it instead. The scapula has betrayed the humerus! Without the 'acromion,' the arm's movement would be free of any restriction. But as mentioned earlier, the acromion is essential because it has to hold both the clavicle and deltoid muscle (refer to page 354). That is why this situation is inevitable.

As such, when our arms are raised beyond a right angle, the upper part of the scapula comes close to the median sagittal plane. In other words, the lower part of the scapula moves laterally (outward). We call this movement supraduction. However, the scapula cannot perform unlimited supraduction. There are endless hurdles for the arm ahead.

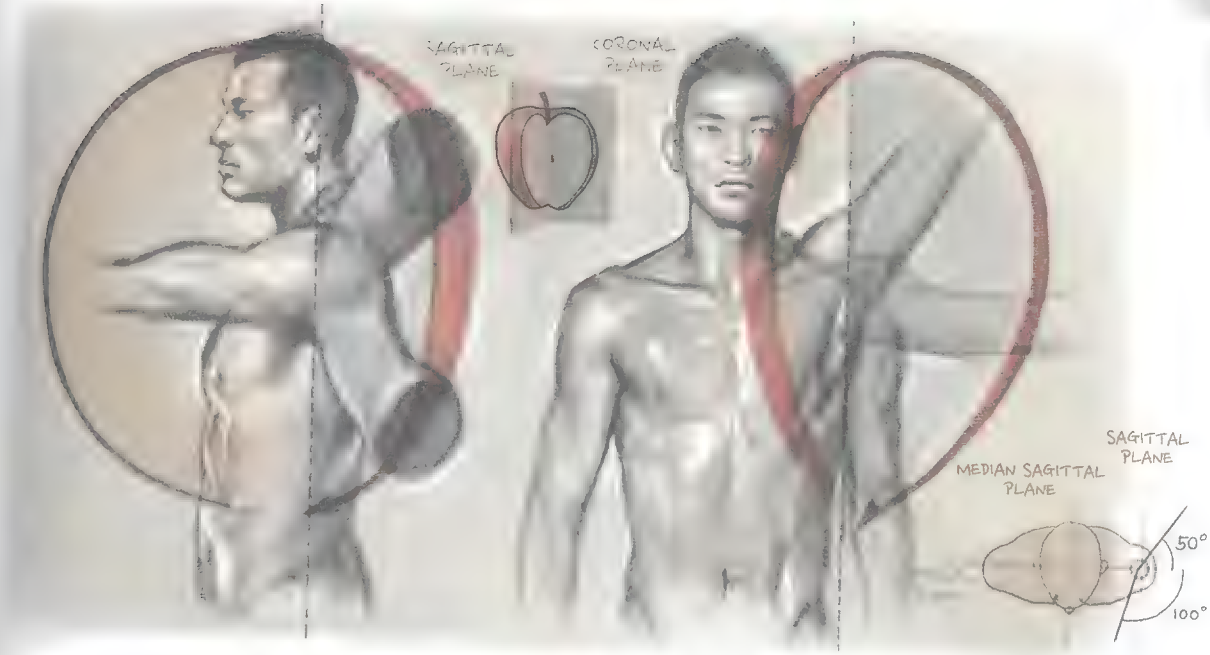


There's a saying that if you don't have a dime, use two nickels. There's a limit to how much the scapula can do supraduction, but just like the above picture, the humerus can be pulled up further beyond 180° (max 205°) by using the torsion of the humerus.

It would be great if we could wrap up here and move on, but there is another movement hindered by the acromion.



Therefore, when you rotate the upper arm you will make a 'D-shaped' circumduction motion rather than a circular shaped one. Please refer to the next picture.



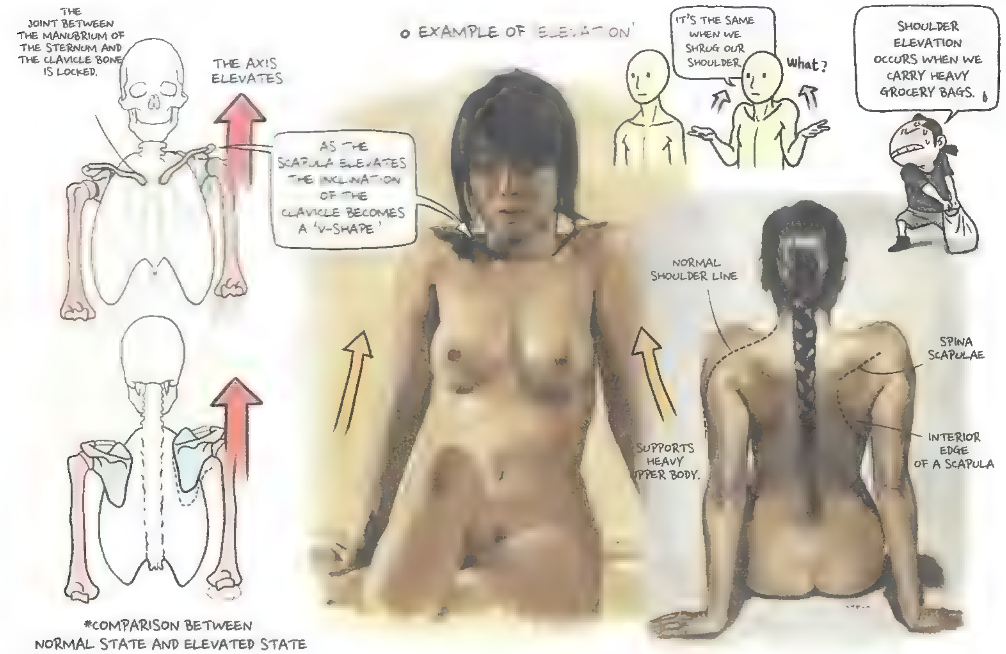
Circumduction of the upper arm. The picture on the lower right shows the range of motion of the humerus when the arm is lifted horizontally.

As you can see in the above picture, circumduction of the humerus is a combination of flexion in the sagittal plane of motion and adduction in the coronal plane of movement. It is not the arms simply rotating.

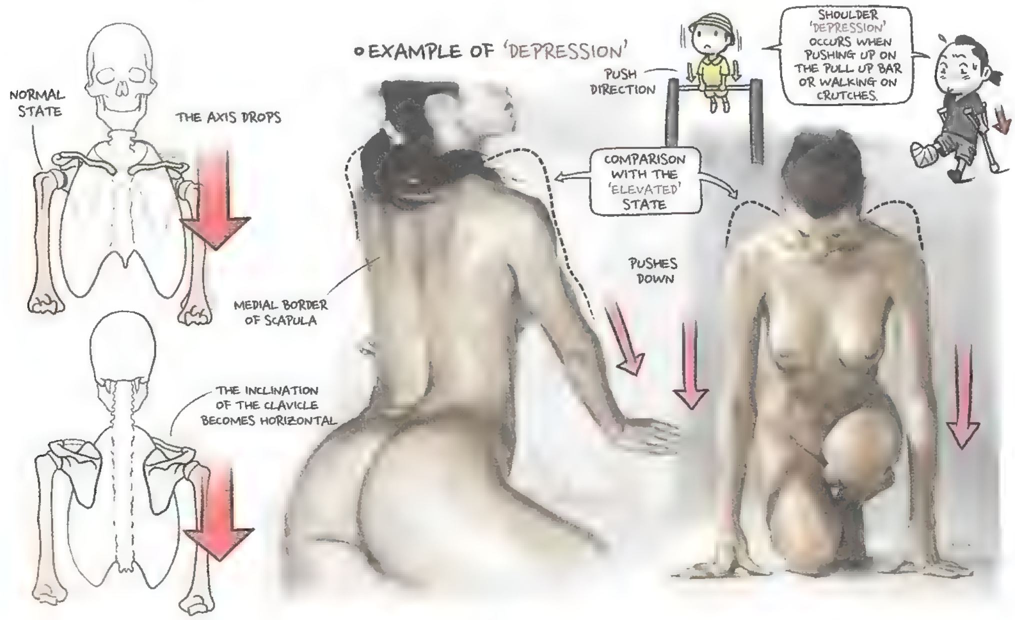
■ Movement of the Shoulder Girdle

We learned that the movement of the humerus affects the shoulder girdle and vice versa. There are many other movements made by the shoulder girdle and humerus together. Let's review the shoulder girdle that is directly connected to the humerus. We will also take a look at other movements through nude drawings that I drew using the painter program.

❶ **Elevation:** Action of 'shrugging' the shoulders are called the elevation. The entire scapula elevates and therefore the acromion and the connecting part of the clavicle move vertically upwards. The elevation usually happens when you lift something heavy or when you support the weight of the upper body, just like the example below.

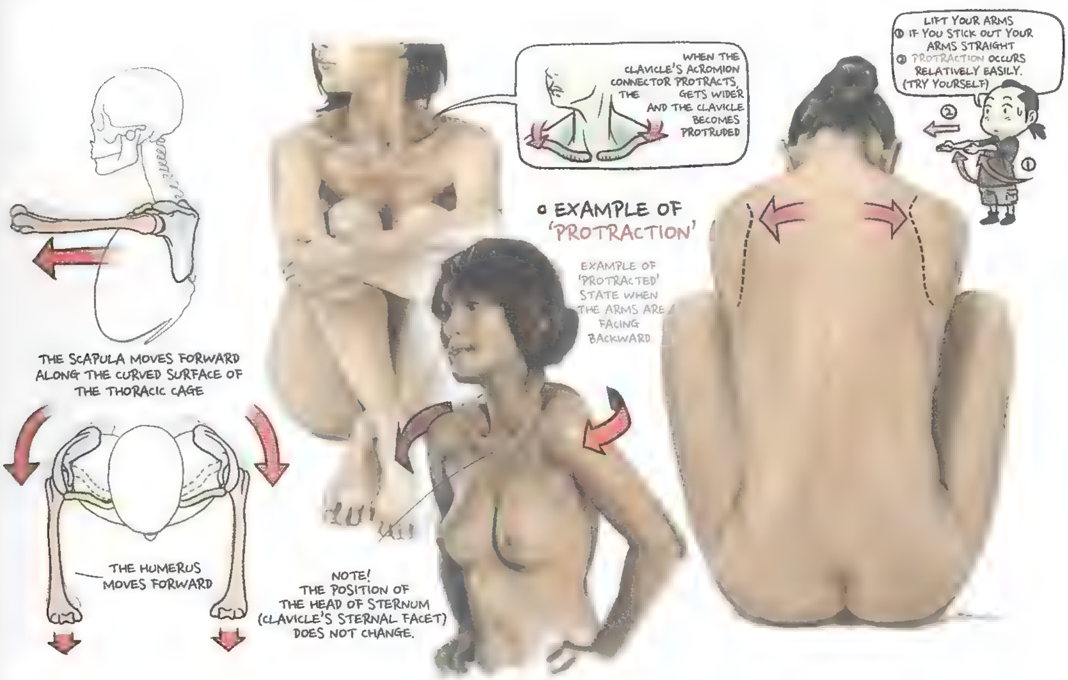


❷ **Depression:** Opposite of 'elevation,' depression is the downward movement of the shoulder girdle. The clavicle moves downward as well but compared to 'elevation' the range of motion is relatively small. The depression can be observed better when you try to push your upper body from the ground rather than consciously trying to depress the shoulder.

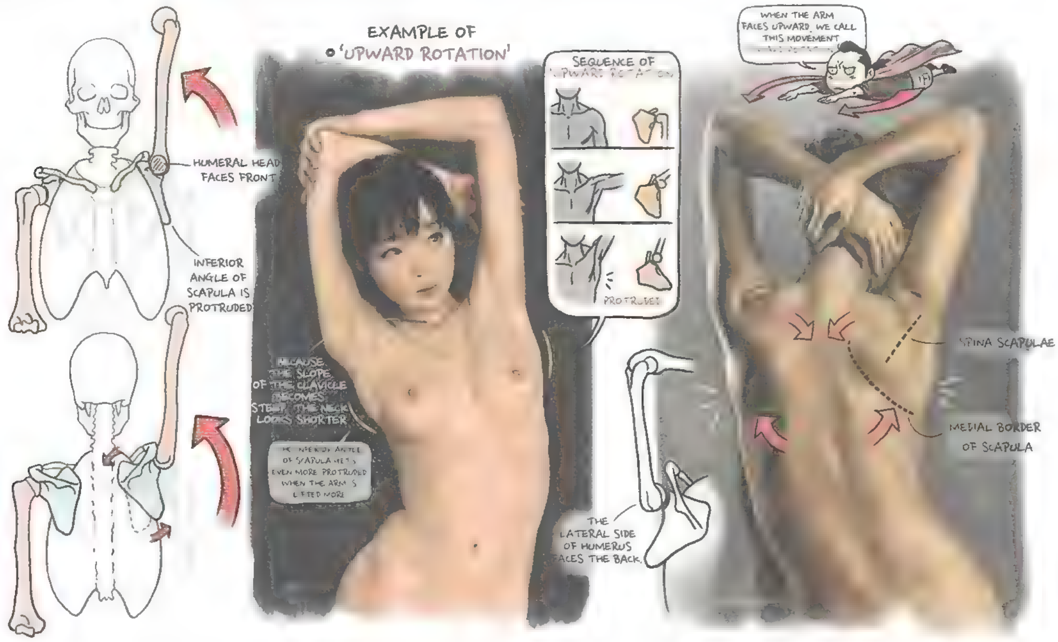


- **Retraction:** Retraction is pulling the scapula toward the spine, toward the sagittal plane. It looks like the arms are pulled back. Thus, retraction occurs when both arms and chest are open widely.

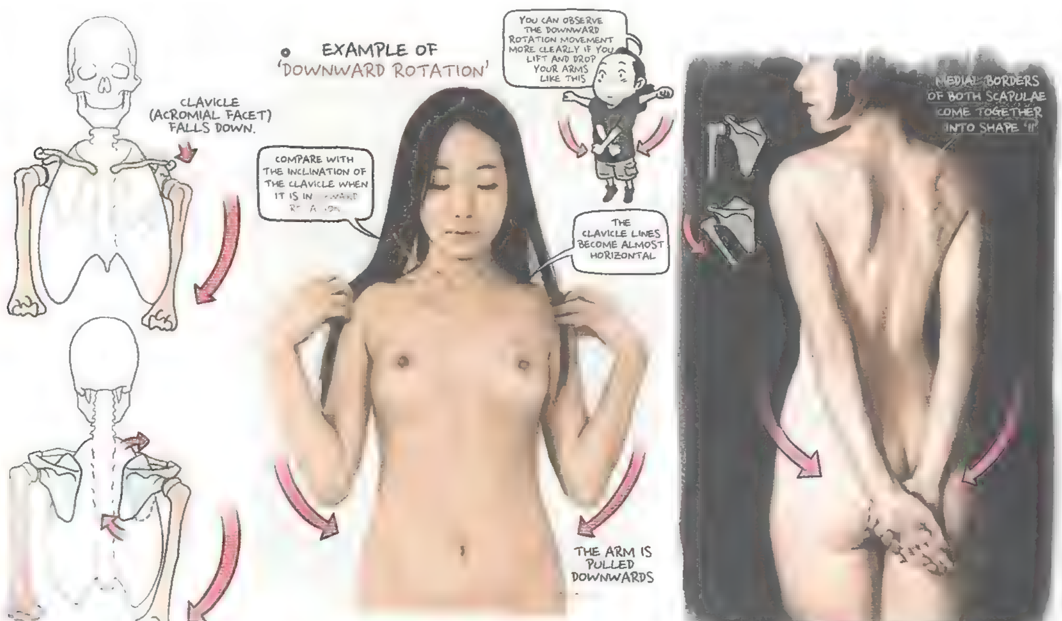
- **Protraction:** Opposite of retraction, protraction is when the entire shoulder girdle moves toward the front. The clavicle moves forward as well and thus, the space between the neck and clavicle becomes wider. Protraction can be observed when both arms are stretched toward the front or when you curl up your shoulder.



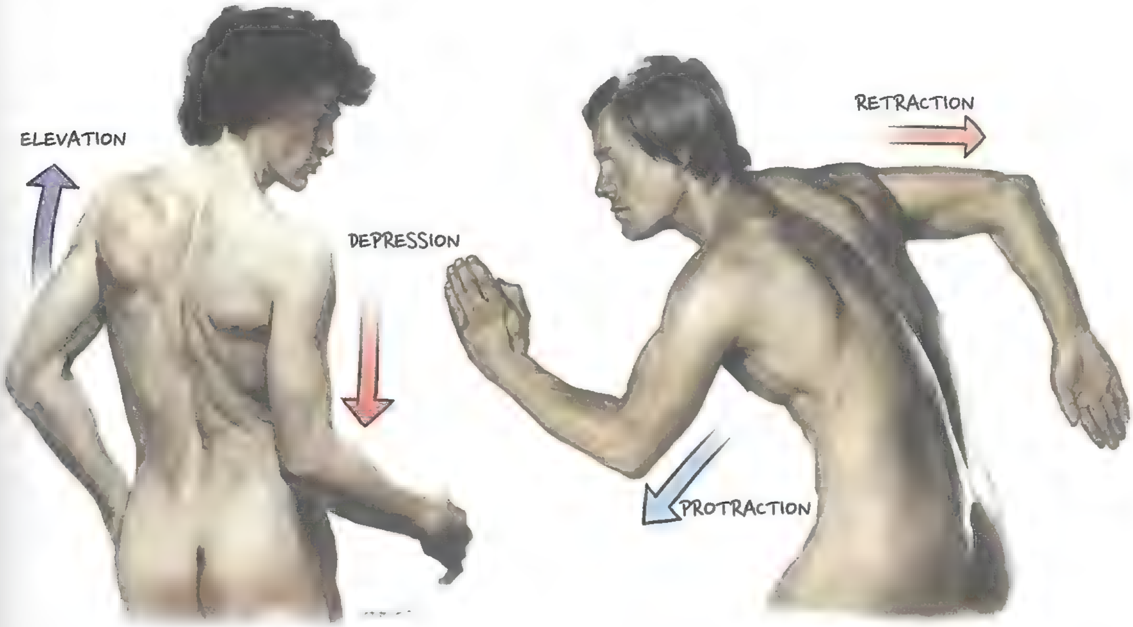
❺ **Upward rotation:** Upward rotation occurs when the arm is lifted 90 degrees overhead. It is the rotatory movement of the scapula where you are moving scapula laterally and upward. As a result, the inferior angle of scapula is protruded and when the arm reaches 90 degrees of elevation, the humeral head will rotate to the frontal plane. The inside of the arm will face front (In short, the armpit faces forward).



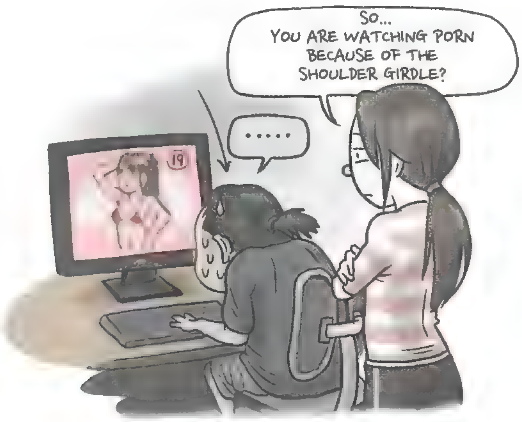
❻ **Downward rotation:** Opposite of upward rotation. It is also a rotary movement of the scapula where the glenoid cavity faces downward. This rotatory movement often occurs when hands are clasped behind the back like the picture below. Downward rotation is the scapula's rotatory movement, so do not to confuse it with depression, where the whole scapula is brought down.



As such, the humerus attached to the 'shoulder girdle' made up of the scapula and clavicle can move in various direction— front, back and side to side. Also, the human body is symmetrical based on median sagittal plane. Thus, given the left and right movements, different combinations of independent movements become possible.



That's it! We have finally learned about the axis of our arms—the shoulder girdle and humerus. To recap, it is the arm that gives expression to the upper body that is fixed by the thoracic cage. The humerus is greatly affected by the motion of the shoulder girdle, but this part is often covered by clothes and unnoticed compared to the movement of the hand. That is why it is useful to keep an eye on how this part moves when watching sports broadcasts.



■Flip Up and Down, Forearm Bone (Radius and Ulna)

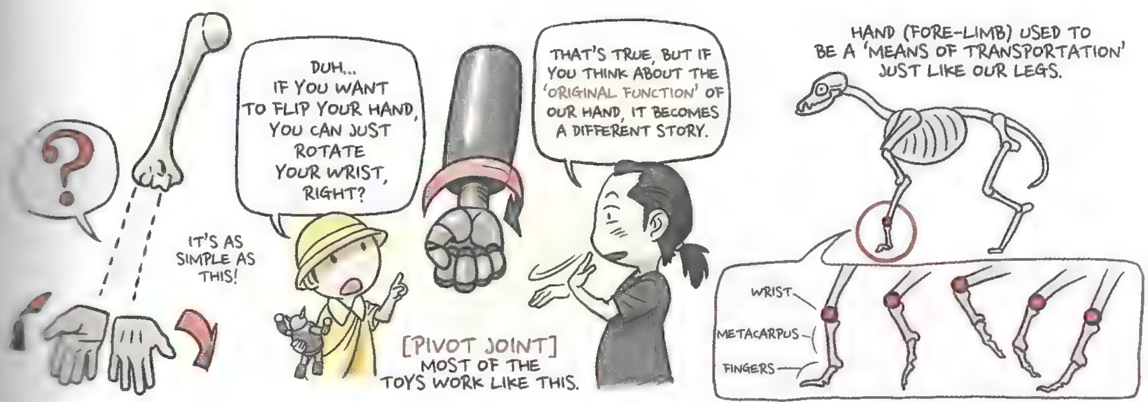
Before moving onto the forearm, let's recall fond memories of our childhood. When we used to play with friends, there was a chant we sang before the actual game to divide the teams. That chant was…

This chant was used to divide the teams. It was called'dedencchi' in some areas. 'Dedencchi' meant 'hand, sky, ground' pronounced in Japanese. So, it means upside or downside.

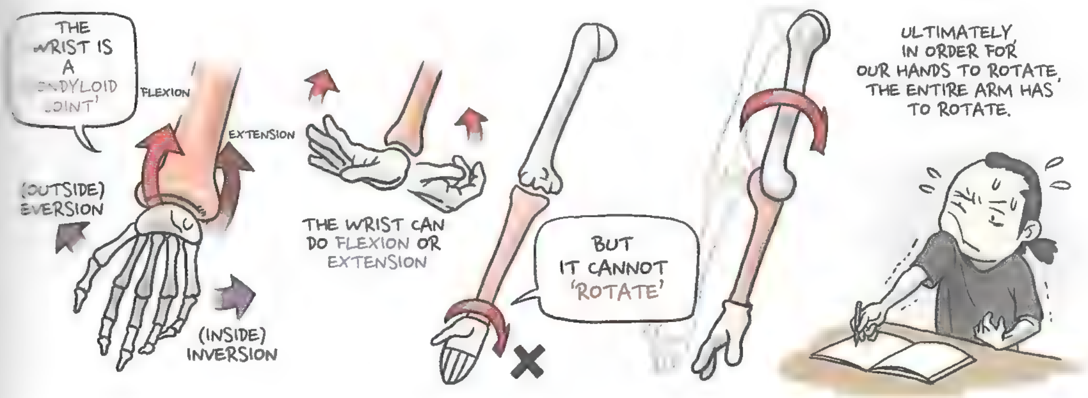
Please remember the chant, flip up or down. These words will appear frequently. Anyways, this simple chant played to divide teams consists of palm supination. A palm flip is a proverb that is often used to refer to a very easy task, just like the proverb we all know, 'piece of cake.' Just like what the proverb entails, hand supination is an easy and simple movement. However, just like the 'flexion/extension' movement, supination is a very useful and important movement for human survival.

If you want to understand how useful and convenient it is to be able to 'flip up your palm,' try to play guitar, write or flip through the pages of this book with your palms facing forward (in anatomical position). In other words, if you can't flip your palm, many of the daily activities (just like the picture before) that we take for granted will be extremely difficult to perform. It is fair to say that flipping our palms is important, right?

As important as it is, the problem is that this movement is not that simple. If that's the case, here's a quick question! 'Which part of the arm needs to rotate for hand supination?'

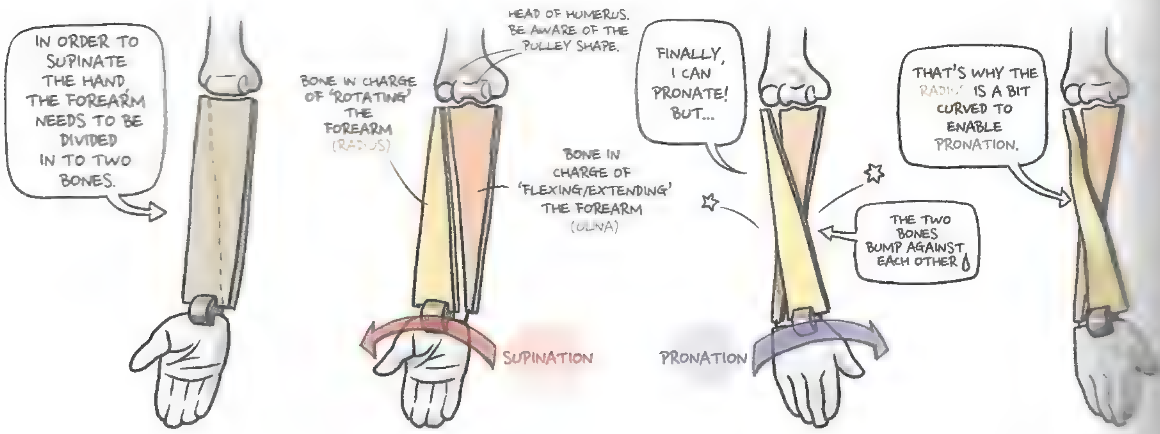


If we consider the fact that our hands were originally used as a means of 'mobility' before it evolved to grab things, 'flexion/extension' movement is more important than the 'rotation' of wrist joints. Therefore, the wrist is an 'ellipsoid joint' that is closer to a hinge joint, rather than a pivot or ball-and-socket joint. For that reason, the wrist cannot rotate (refer to page 50).

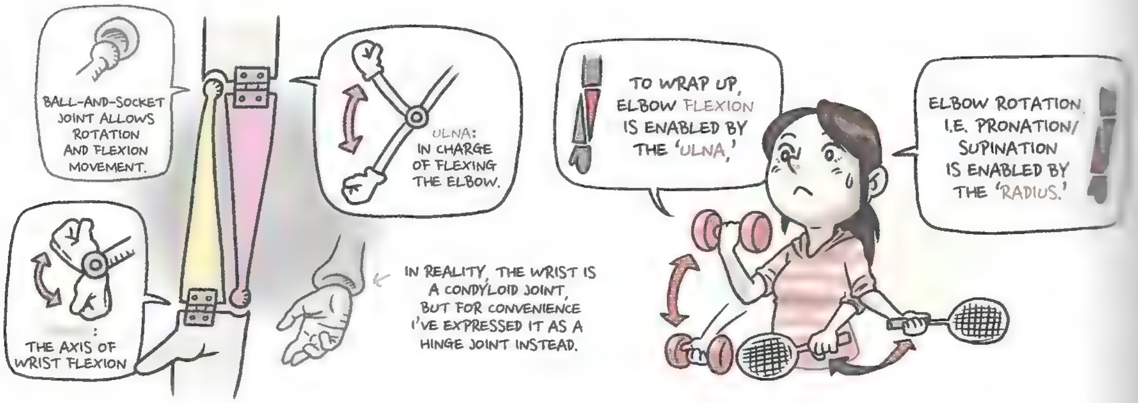


Nevertheless, as I explained earlier, 'hand supination' is essential to humans. What a difficult situation! In order to make the impossible possible, it became necessary to improve the forearm's structure.

First of all, we call the 'palm up or down flip,' in other words, the motionof 'pointing the thumb down toward the median line or up laterally, 'supination/pronation.' In order for the forearm to do flexion/extension as well as 'supination/pronation,' it needs to consist of two separate bones.



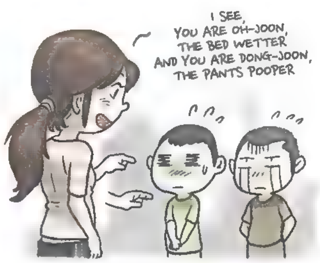
As a result, the bone of forearm consists of two bones: the radius that is in charge of pronation supination and flexion/extension of the wrist and the ulna that is in charge of the basic flexion extension function of forearm. Thanks to these two bones, the forearm can be flexed and extended, supinated and pronated.



We already learned about the 'flexion/extension' movement before, so now we should also take a look at 'supination/pronation.' In order to do that, we will have to look at the shape and structure of the forearm first. Let's remember the outline we just covered and move on to the next chapter.

In the Name of Ulna and Radius

The picture on the side is a drawing of an actual forearm sample.
But no matter how detailed the sample drawing, it is difficult to know what at this point is.
We know that the bones are called 'ulna' and 'radius' but other than that, they just look like two mismatched chopsticks standing side by side.
At this point, it is difficult to tell which is which.
Anyways, anatomy is not easy.
However, the situation can get better when you learn the meaning behind the names. It is like learning the names and characteristics of two brothers who look alike.



I remember when I first started to study art anatomy, I could not figure out why these bones were named the way they were. Why are they called radius and ulna?

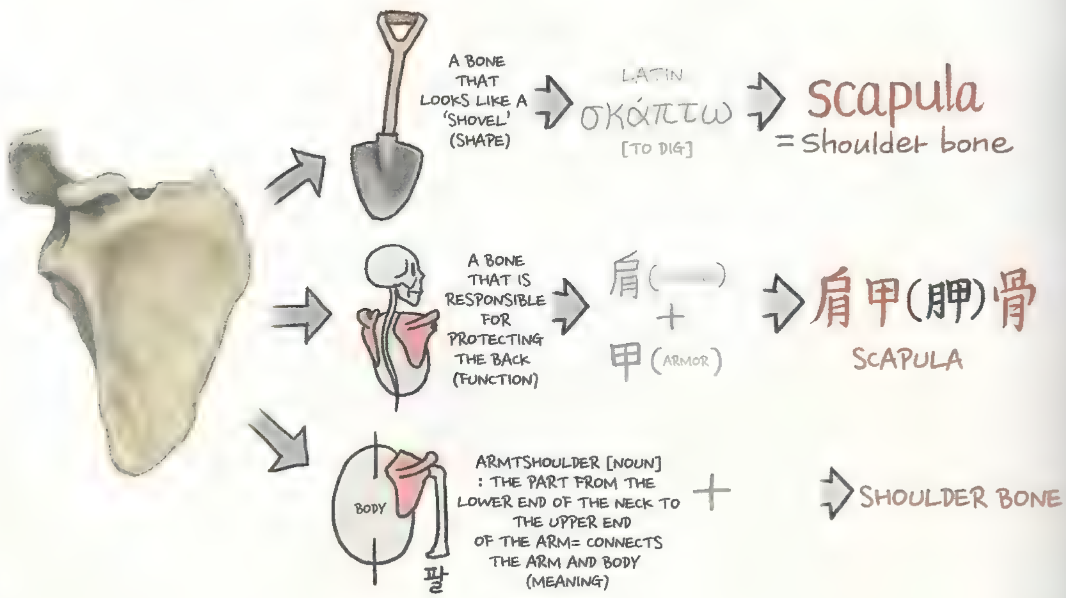
For your reference, bones are actually bright pink because the blood inside the skeleton is visible.
The 'white' skeletons we are familiar with have been bleached.

If you know the origin and meaning of a name, it will be easier to memorize the terms. Now, let's look at these bones that form our forearm.

Wait! The Origin of Anatomical Names

In early 2000s, when I first started studying art anatomy, what we now call 'ulna' and 'radius' were still called by their Chinese names. The names were so difficult I was about to give up but I accidentally spotted a Chinese character dictionary covered in dust. Just like a person stumbling in the dark, I started to fumble through the dictionary looking for the meaning of the Chinese characters.

I was surprised to find that the names of the bones that I had a hard time memorizing had meanings to it. After learning the origins of these names, not only did the bones look different, but it was easier to connect the muscles associated with the bones. After realizing this I started looking at the meaning of different bones and muscles whenever I could. As a result, just by looking into the origin of their names, I could remember more facts about the subject itself. For instance, look at the example below:



Even though this is the case, because the anatomical terms are very specialized and difficult, the deeper you get into, the harder it is to find the 'origin' of the terms. So, in the beginning, it was very confusing but the more I studied, the more I could see the 'pattern.'

The following anatomical patterns are my own analysis. Therefore, I recommend only to those who are new to studying anatomy.

❶ Location	The 'location' of the musculoskeletal parts is the key. Names often have descriptive words such as 'superior' and 'inferior,' 'anterior' and 'posterior' and 'medial' and 'lateral.'	Upper arm <-> lower arm Spina iliaca anterior superior <-> spina iliaca posterior inferior Medial, intermediate, lateral cuneiform
❷ Size	A prefix is added to depict the 'size.' These parts are different sizes but they have similar functions. Just like the 'location,' it is common to add the 'size' to the name. If there is a 'major' then there will be a 'minor' nearby. It is fun to find each pair like this.	Pectoralis major <-> Pectoralis minor
❸ Shape	The name contains information such as a specific shape, angle, area etc. This naming pattern is more commonly found in muscles than in bones. You can often guess what the muscles look like just by the name.	Deltoid, Sternocleidomastoid, rectus abdominis, latissimus dorsi.
❹ Function	The name of the parts is often given based on a particular role or function. This naming pattern is also more commonly found in the muscles.	Shoulder girdle, levator muscle, sphincter muscle
❺ Analogy	The naming pattern alludes to an object or phenomenon. It is often associated with unique features (main example: clavicle) as well as the shape of an actual object.	Clavicle, ulna, radius, talus, ankle bone, cheekbone.

As was mentioned earlier, anatomy is more about rote memorization. There are so many things to memorize. Most students who study anatomy have a hard time memorizing but just a few of the patterns that we've introduced above will greatly reduce such burden.

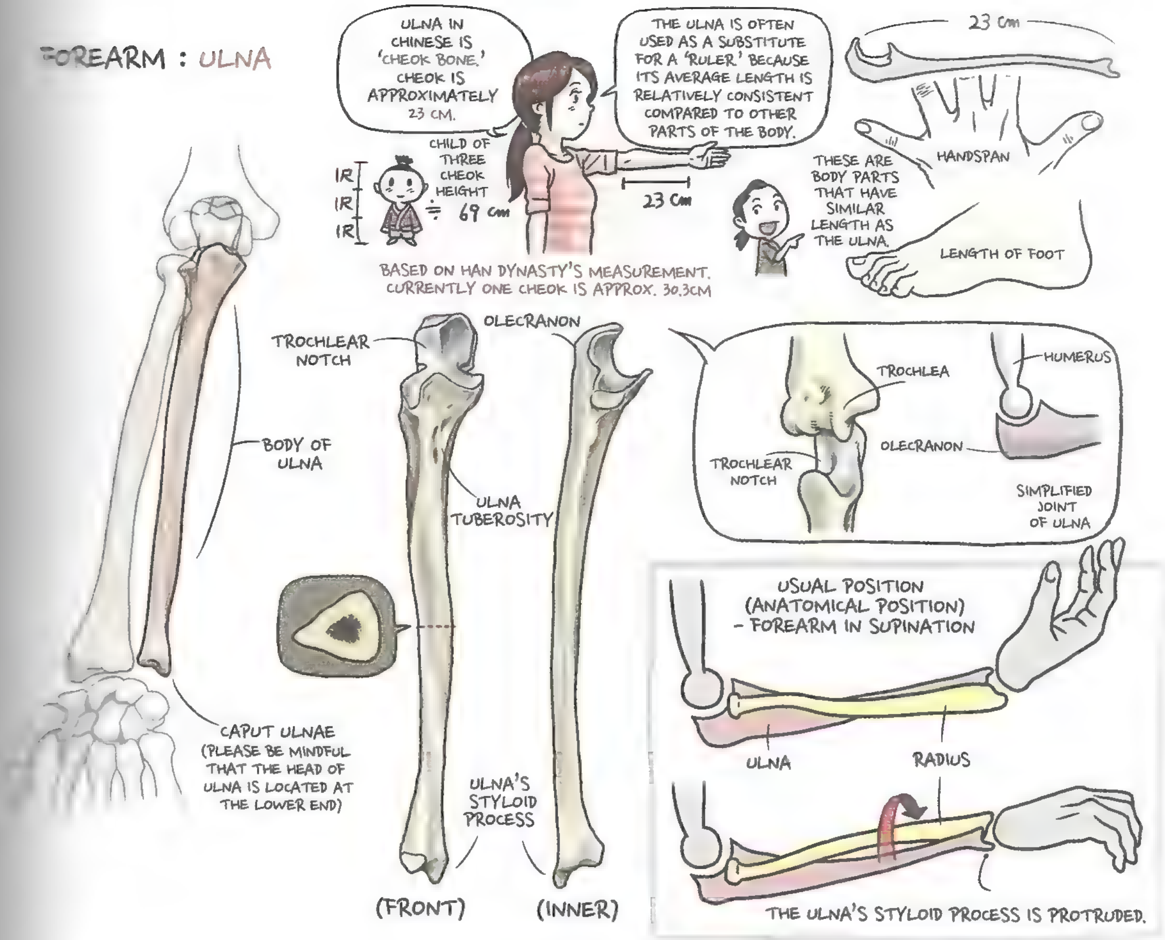
If you think about the process over the centuries that the human body has been dissected, observed and documented by countless scholars since the discovery of anatomy, you can imagine that there is not a single organ or part of our body that has been named randomly.
Each of the names were probably created so that future generations and students would better understand. So, for a student interested in the field, it would be a good experience to learn the meaning behind each name.

This is random trivia information, but I owe this book's existence the words ulna and radius. Hail to ulna and radius!

❶ Ulna

Before we look into the origin of the name 'ulna,' let's look at the function and appearance first. The ulna plays a vital role in how the forearm performs flexion/extension movement, which is the most basic movement of arms. The ulna is one of the two bones found in the forearm (the one toward the pinky finger). It articulates with the humerus to perform flexion/extension movement of the forearm. The ulna is approximately 22~24cm and longer than the radius and unlike the radius, the upper end is thicker, and it gets thinner towards the lower end.

FOREARM : ULNA

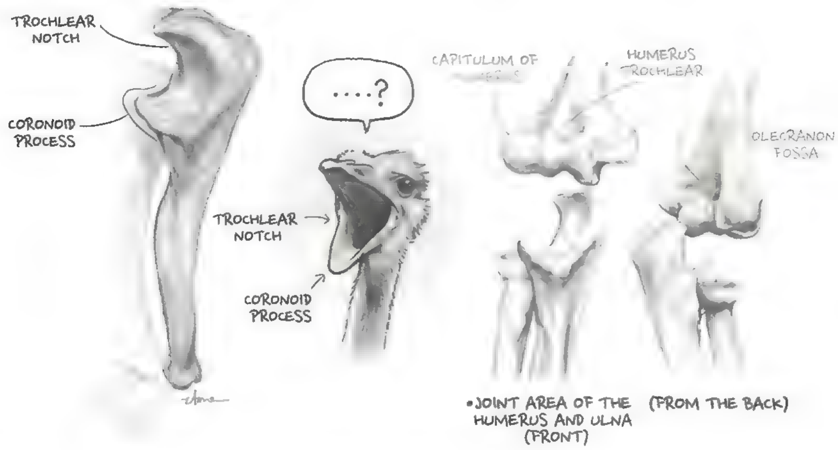


Compared to the radius which is in charge of both flexion/extension and pronation/supination movement, the ulna is the axis of a forearm. Therefore, the location of the bone does not move even during pronation/supination movement.

Below are ulna's specific names:

- **Olecranon:** Olecranon is the pointy bone at the tip of the elbow when we bend our arms. We often call this area the 'elbow.' It touches the Olecranon fossa which is a deep triangular depression on the posterior side of the humerus. Also, the triceps brachii (refer to page 355) is attached to this area therefore it is very protruded.

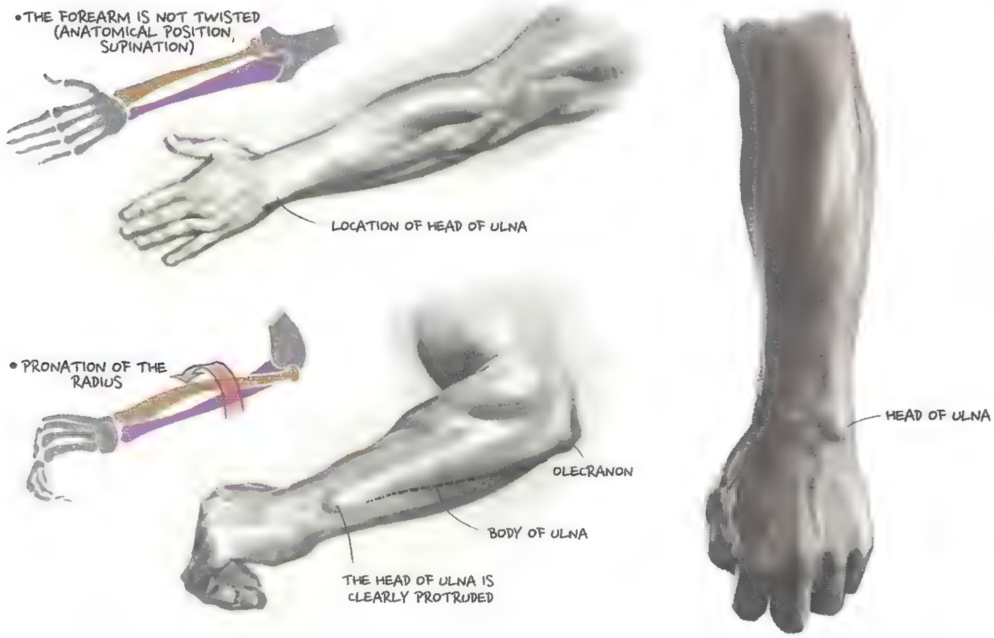
❷ **From the back:** Trochlear notch: It looks like a bird opening its beak. The trochlear notch hooks the humerus trochlear which enables flexion/extension movement



❸ **Tuberosity of ulna:** The front of the body is a rough eminence like a velcro which gives insertion to a part of the brachialis in order to perform flexion/extension movement.

❹ **Body of ulna:** The body of ulna is a triangular in cross-section. The interior corner facing the radius is the sharpest. The radius, which we will look into shortly, also has a similar cross-section.

❺ **Head of ulna:** Even though it is called the head of ulna, the head is located toward the thumb. Normally (in supination position) it is not visible, but it is easier to spot it when the forearm is placed in pronation which is when the two bones of forearm overlap in an X-shape.

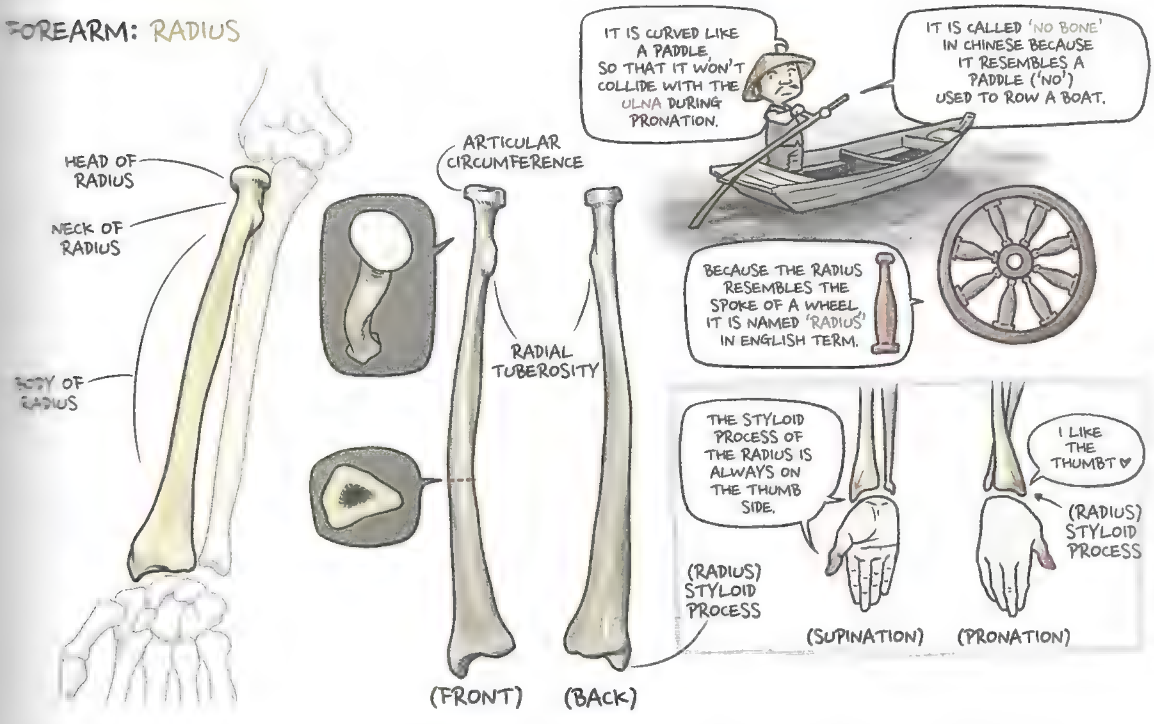


- **Styloid process:** The name is derived from a stylus pen (styloid <- stylus). It is found at distal end of the head of ulna and projects from the medial and back part of the bone. There's also a styloid process of the radius which we will learn in detail shortly. Ulna's styloid process is smaller in size, but it is positioned higher up compared to that of the radius which makes the hand's inversion easier. For more information on this, please refer to the explanation on styloid process of the radius.

❷ Radius

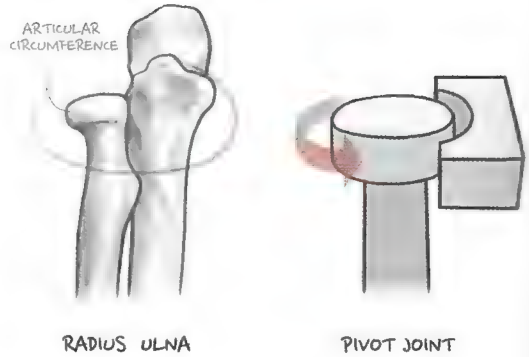
This bone is called the 'radius.' 'Radius' in Latin means the spoke of a wheel, which this bone is thought to resemble.
As mentioned earlier, in anatomical position, both the ulna and radius are in parallel position but when pronated, the bones overlap in an X-shape. This is why the radius is slightly bent outward. As a matter of fact, the radius is in charge of supination/pronation movement.

The average length of the radius is approximately 20~22cm and it gets thicker toward the distal end and holds most of the wrist.



Unlike the upper 'head of radius' which is fixed, the lower part of radius (styloid process) changes position based on the supination/pronation movement. As the position changes, this might cause confusion but just remember that the styloid process of radius only follows the thumb. Below are the radius's main parts.

❶ **Head of radius:** The head of radius is attached to the capitulum of the humerus. Also, due to the 'articular circumference' which touches the ulna as a pivot joint allows both flexion/extension movement and pronation/supination movement.



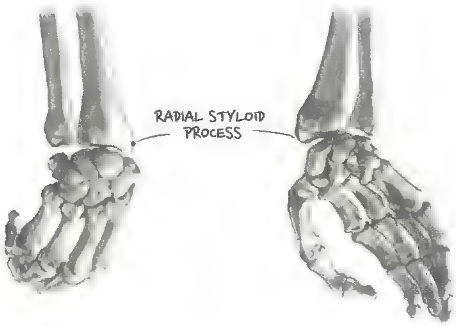
❷ **Neck of radius:** It is a concaved part beneath the head of radius.

❸ **Radial tuberosity:** The protrusion is in between the neck and body of the radius. It is also where the tendon of the arm's major muscle 'biceps brachii' (refer to page 354) inserts. From 'head of radius' to 'radial tuberosity' is the upper part of the radius.

• FIGURE OF RADIUS FROM THE TOP

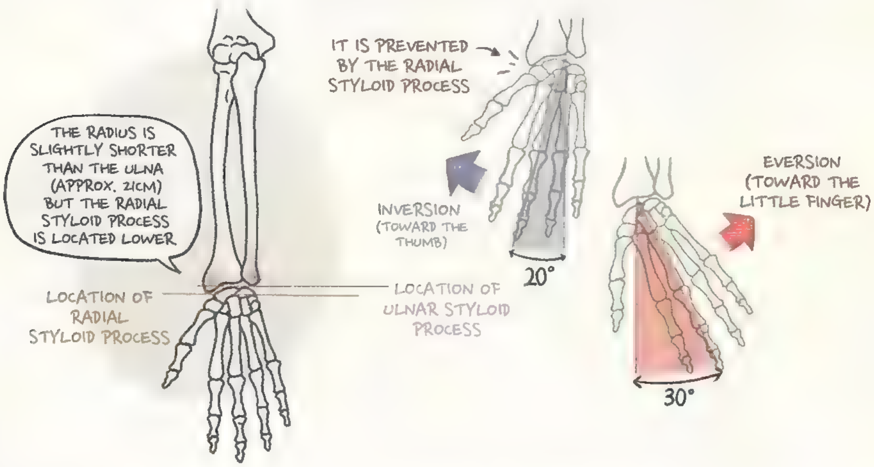
❹ **Body of radius:** It is shaped like a bent bow facing towards the exterior. It has the shape of a triangular cross-section with three sides and three corners, as it holds several muscles that bends and unfolds the wrist and fingers. Towards the thicker bottom, the triangular cross-section becomes more prominent.

❺ **Styloid process:** The radial styloid process is a projection of bone in the shape of a sharp stylus that stably wraps around the carpal bone. It is relatively bigger than the ulnar styloid process and extends downwards, restricting the 'eversion' of hands.



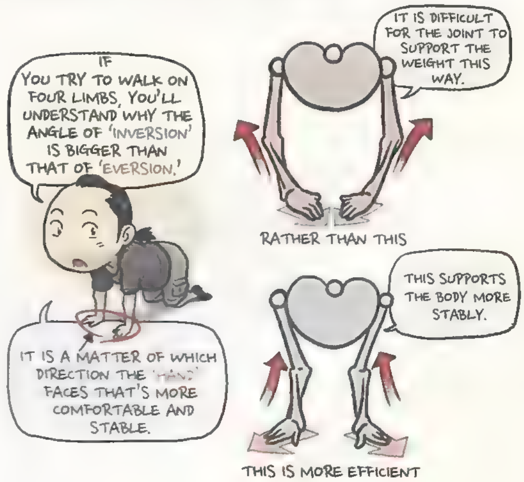
Wait! Inversion and Eversion of the Wrist

As we learned the height difference between the radial styloid process and ulnar styloid process affects the angle at which the wrist bends toward or away from the body. These are respectively called 'inversion' and 'eversion.'
As you can see in the illustration below the eversion angle toward the thumb direction is limited because of the radial styloid process. But the angle toward the little finger direction where the head of ulna is bigger because there is more space. This is what allows us to play guitar comfortably.



The reason why the wrist is designed to bend more towards the little finger than the thumb probably has to do with the use of our 'hands.' It is related to how humans used to walk on four limbs.

If we consider four-legged animals that have to support their upper body solely with their two forelimbs for the entire life, it is a lot more comfortable and advantageous to have their forelimbs to open outwards rather than inwards. Without further ado, you'll understand clearly if you try to hold the position or 'crawl' on your four limbs. To conclude, when walking on four limbs, It is much more efficient and stable when the forelimbs open outward to support the upper body.



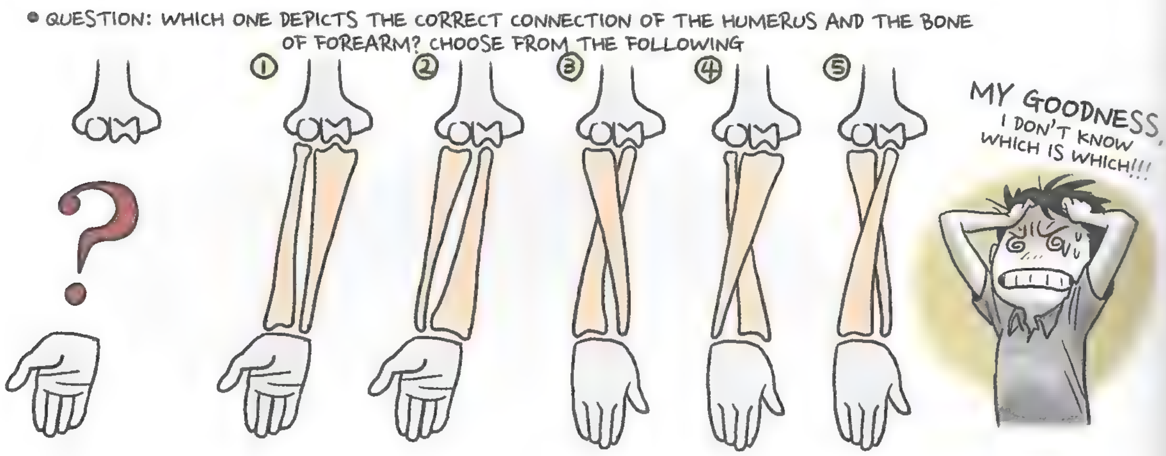
At this point, there might be a number of readers that question 'how are humans that stand upright and animals that walk on four limbs have to do with each other?' I totally understand why some people ask this question. It's only natural that most of us don't remember when we were babies that crawled on all fours.

❸ Pronation and Supination of the Forearm

Let's try to recap the facts we learned about the forearm.

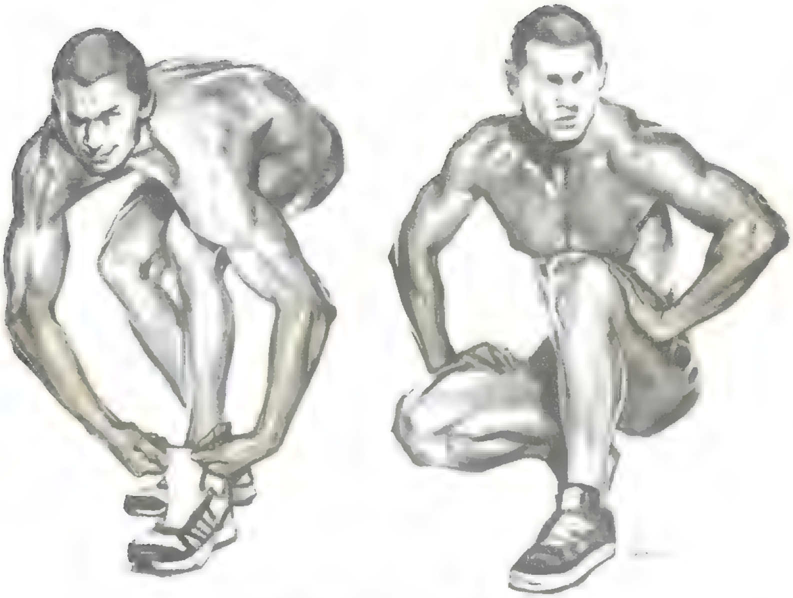
❶ The forearm does 'flexion/extension' and 'supination/pronation' movement.
❷ The forearm contains two bones - 'ulna' and 'radius'
❸ The ulna is in charge of 'flexion/extension' movement of elbows, the radius is in charge of 'supination/pronation' movement.

I'm pretty sure most of you have understood just by reviewing the facts about the forearm, but to be frank, when I was in school studying art anatomy, these simple facts were really confusing to me. If you look at the still arm, you get the idea, but once the forearms start to pronate and supinate back and forth, it is difficult to follow what's actually going on.



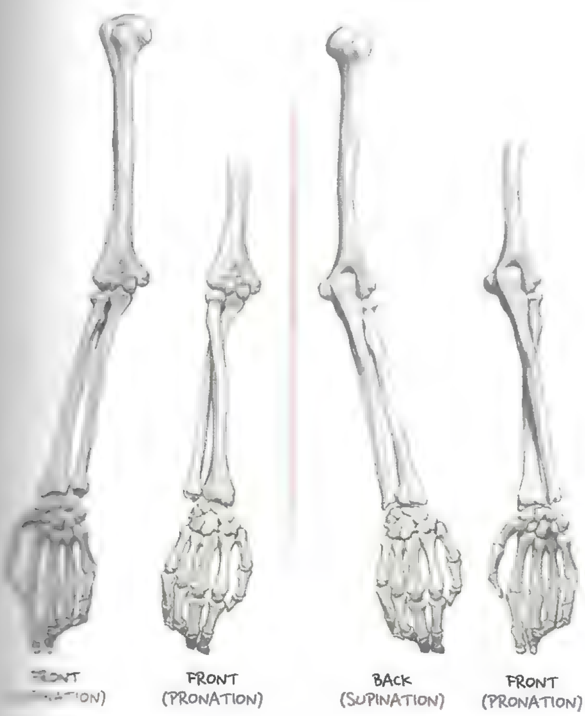
This was one of the questions from my 'anatomy drawing' final exam.
I was able to answer after thinking for a long time but I still got it wrong. What is the correct answer?

To be honest, numerous readers might refute that it's not that important to know this in detail, but as a matter of fact, it is a very sensitive issue when it comes to drawing them. Why? Simply put, the muscles are attached to our bones. As a result, based on whether our forearm is in supination or pronation position, the appearance of the muscles attached to our forearm bones (ulna and radius) will change as well. Additionally, it is quite risky to confuse these two bones when it comes to drawing characters that need to have their 'arms' spotlighted.



Study of Human Poses / painter 12, 2012
In both illustrations, the character has his arms bent in. But on the left, the colored area shows the forearm in pronated position. On the right, the forearm is in supinated position. Observe how the forearm muscles change in shape depending on the position,

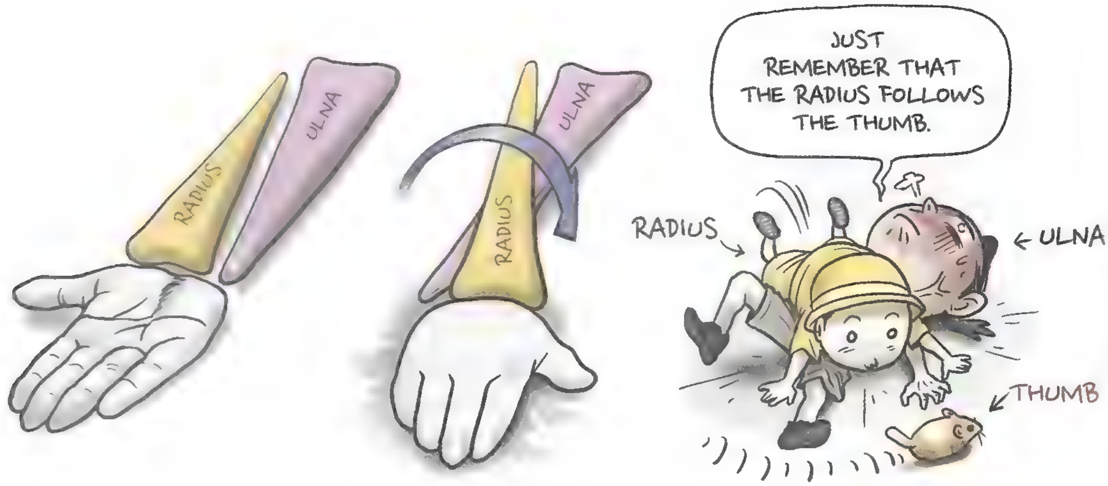
am going to go over the supination/pronation movement of forearms once more in case there are any readers that are still having problem understanding, like I did when I first studied art anatomy. There's no harm in going over once more for better understanding.



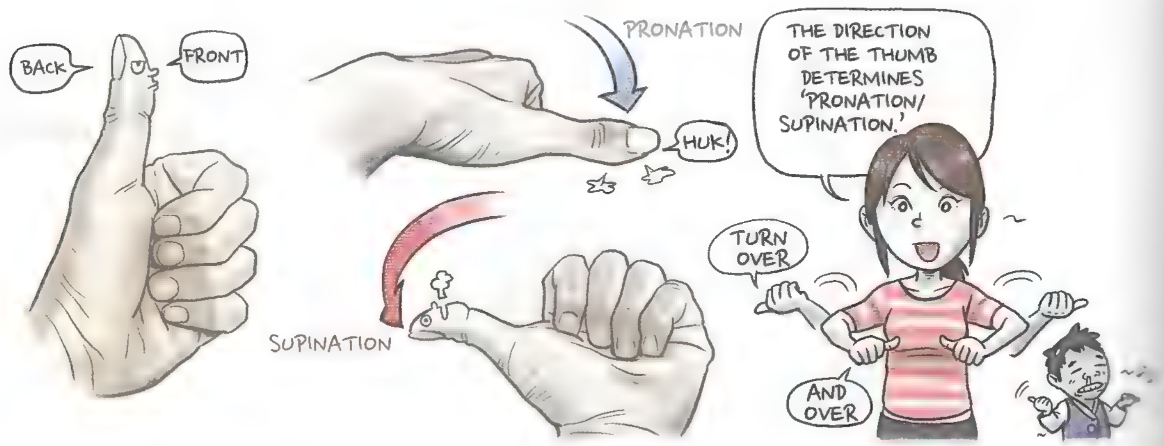
The illustration on the left are the front and back where the 'humerus' and 'forearm bone (ulna and radius)' are connected. You can also see how they are in supination and pronation respectively.

Top illustration shows the differences between 'supination' when the wrist is in abduction (palms facing forward, anatomical position) and 'pronation' when the wrist is in adduction.

If you are still confused, try to imagine like below.

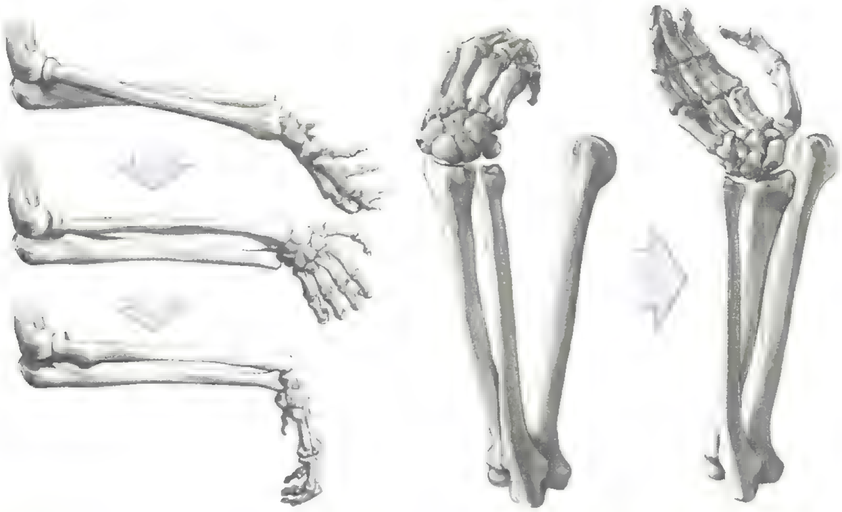


Basically, just remember that the 'radius' is in charge of 'pronation' movement, which always follows the 'thumb.' When the radius 'pronates' the ulna, our hand rotates inwards which naturally makes our thumb to face toward the body. When the palm faces forward, this state is called 'pronation,' and 'supination' is the opposite of this. You might understand the theory but still get confused. Always remember the position of the thumb.



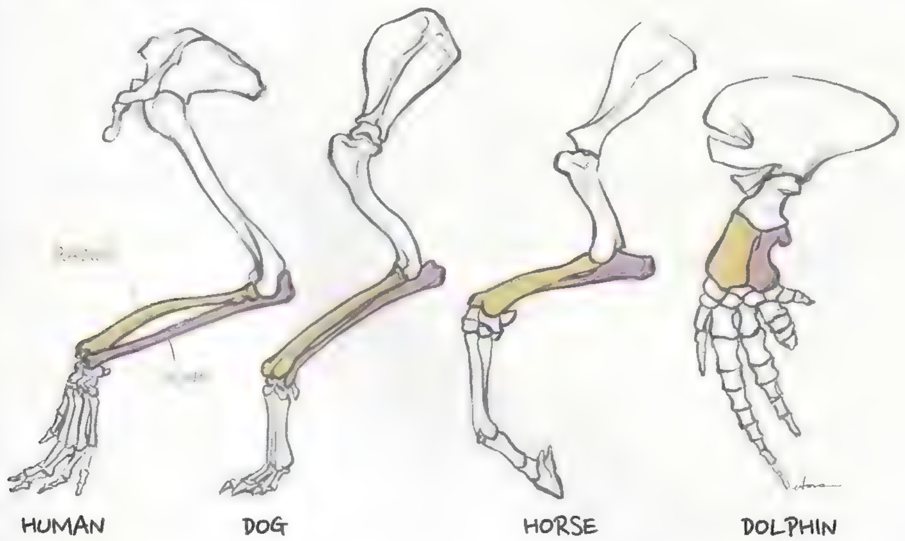
Just like the illustration above, if you clench your fist, unfold your thumb and then turn down your thumb with your fingerprint facing forward, it is in 'pronation.' If you turn over your thumb so that the nail faces the ground, it is in 'supination.' You just need to be able to distinguish the front and back of the thumb, then the problem will be solved. Why don't you take a moment and try it yourself?

Lastly, the next illustration is a depiction of the forearm during 'flexion' changing from supination to the pronation position.



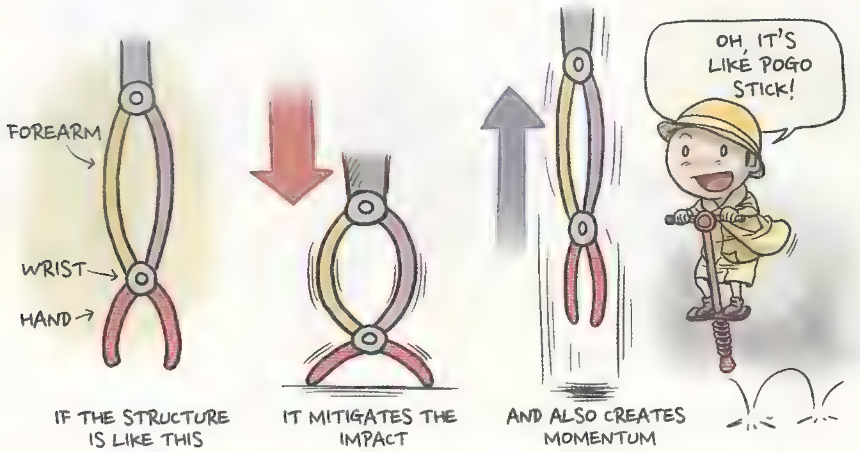
Wait! Original Function of Ulna and Radius.

It is very clear that the 'supination/pronation' movement is possible because our forearm consists of two bones instead of one. But, this is not the only reason why our forearms are made of two bones. I know I have just spent a lot of time explaining about pronation and supination, but I need to mention that there is another fundamental reason why our forearms consist of two bones. But first, let's compare human forearms to another animals' forearms.



The exception of human arms, the basic position of animals is to have the back of their hands facing forward in the pronated position. In the case of horses, the ulna and radius are combined like a single bone but if you look closer there is a trace that shows they used to be separate bones.

As shown in the picture, most animals also have two bones in their forearms just like humans. But they cannot make the pronation/supination positions. Primates such as monkeys, cats and mice that use their forefeet like hands are exceptions. This is for the same reason that animals don't have a clavicle (refer to page 288). In other words, this is to focus the forearm or the forefoot on the purpose of walking only. The forearm is made of two bones to cushion the impact of hitting the ground when walking or jumping, and also to gain momentum.



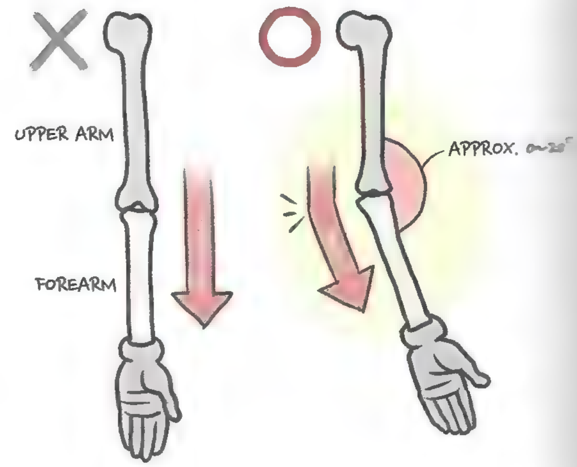
We are going to look at this in detail later but human's lower legs or the shanks also consist of two bones for this reason. That is why the shank is made of two bones, even though it cannot pronate or supinate

Also, having two thin bones is much lighter and sturdier than just one thick bone. Two bones provide more space for muscles to attach so they are useful in many ways.

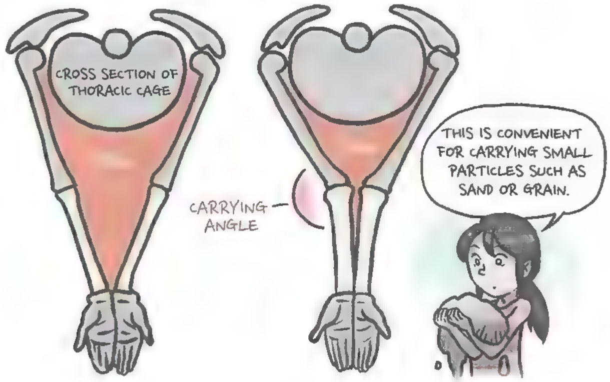
In the meantime, humans evolved their forearms out of need. Of course, there may have been side effects, but the desire for survival is extremely powerful enough to change many things.

■Carrying Angle of Forearms

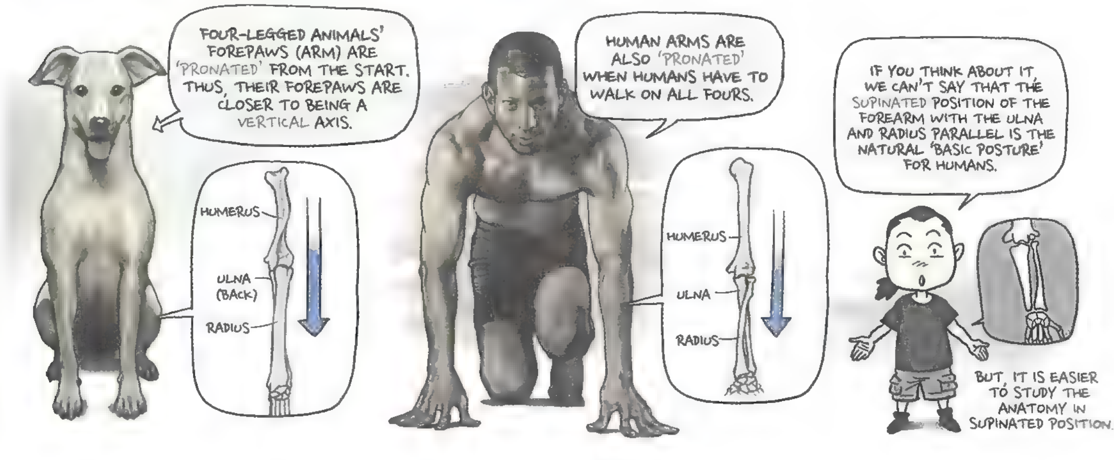
It is not easy to spot the carrying angle of forearms as it is very subtle, but if you are an observant person, you will have noticed that the angle between the forearm and upper arm is slightly bent outward. It is not straight, during supination (refer to page 331). 'Supination' is the rotation of the forearm and hand so that the palm faces forward. Moreover, when your arms are held out at your sides and your palms are facing forward, your forearm and hands are



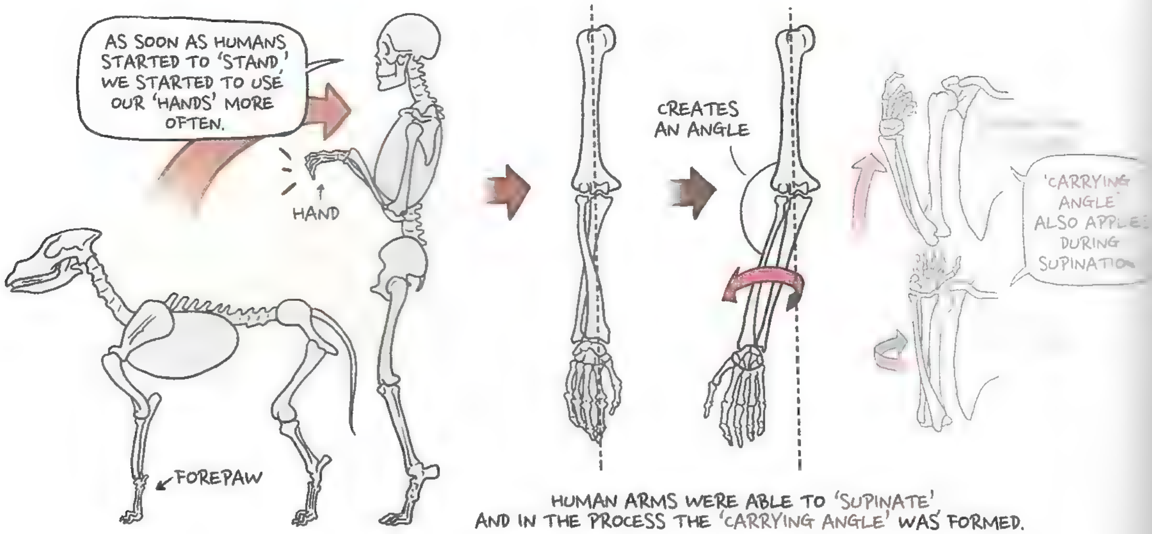
about 10 degrees away from your body. This slant is called the carrying angle of the elbow. As the arms stick out from the body like that, it's convenient to carry objects with one hand. Also, the name 'carrying angle' was given as it creates space when forearms are put together, making it easier to hold something.



Although, the word 'carrying' was added to the term, the 'carrying angle' would not have been formed solely for the purpose of lifting objects from the beginning. It is relatively recently that the arms of human beings deviated from the role of the foot. So, why and how did this carrying angle come about? To find out why, let's compare it to the forepaw (arms) of other four-legged animals.



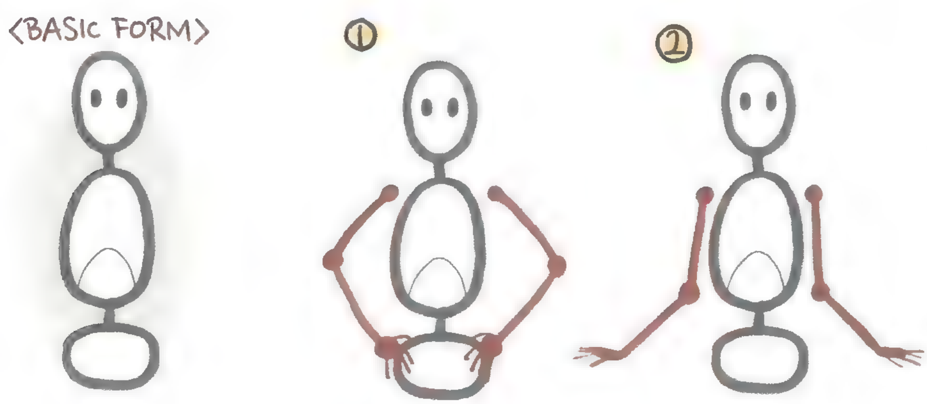
As we have just learned, the basic posture of most four-legged animals' forepaw is to be in 'pronated' position where the ulna and radius overlap in an X-shape. The upper and lower paws are almost vertical. The two forelimb bones, instead of being parallel, cross each other in an X-shape to support the weight of the torso when walking. This applied to humans as well when they used to walk on four legs but as soon as humans started to stand, big changes happened to the arms.



After humans started to stand on two feet, the carrying angle developed naturally once the need to 'supinate' led to the rotation of radius based on the ulna that is in charge of supination. As mentioned earlier, being able to actively use our hands (being able to pronate and supinate the forearm) is a necessary part of human survival. Ultimately, I think the 'carrying angle was a bonus added because of humanity's desperate desire to survive.

❶ Carrying Angle, the Secret Key.

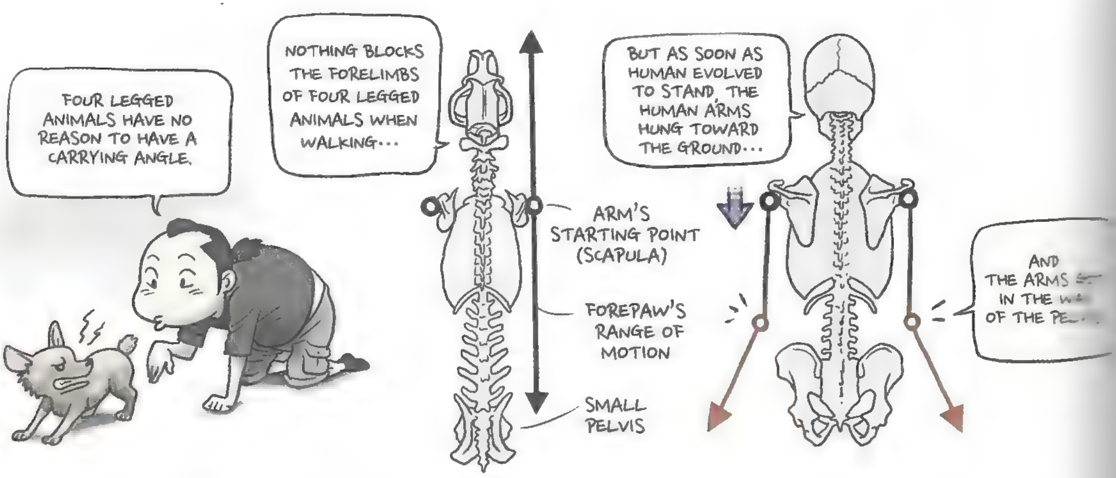
In a way, the slightly curved arm is a little deformation, but the effect of this small difference on the human form is more significant than you might think.
Let's first look at the illustration below. On the far left is the 'basic form' and ① and ② have different arm shapes. Among ① and ②, which do you think it more masculine or feminine?



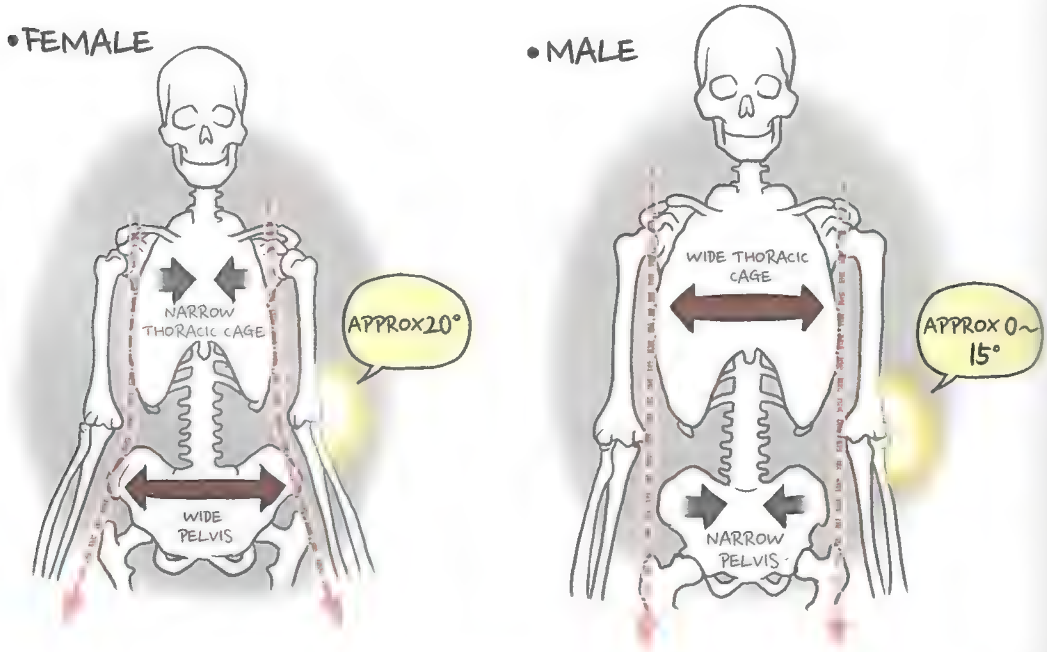
I'm pretty sure most of you think ① as masculine and ② as feminine. To tell you the answer, it is because women have a larger and more acute carrying angle than men. Anatomically, men's carrying angle is approximately 0~15' and women's carrying angle is approximately 10-20'. Then why do women have a more acute carrying angle than men?

Of course, the carrying angle was formed due to the increased role of hands. But the difference in size of the carrying angle between men and women is due to a more fundamental reason. First, it is essential to figure out which part of the body is most different between human and four-legged animals. That part is…

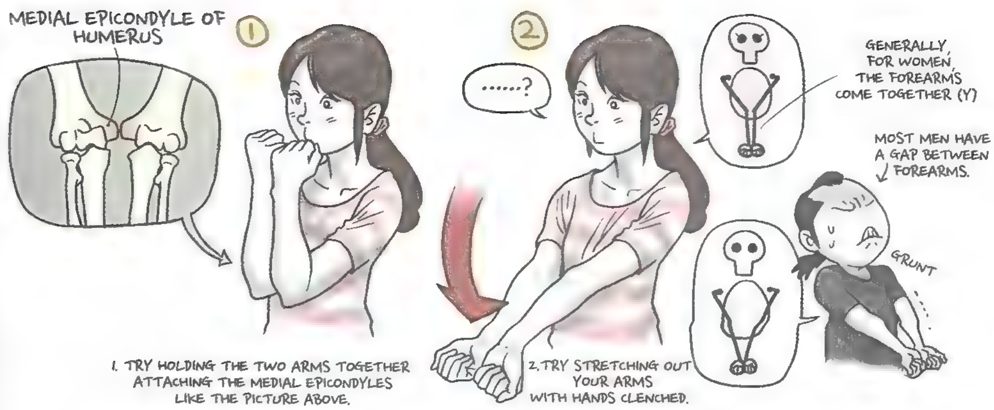
Yes, that's right. We learned that in the case of humans that have to stand upright, the pelvis is much bigger in order to support internal organs pressing down. As we started to stand, the location of our arms also changed. In conclusion, the angle of our upper/forearm or the carrying angle was affected by the size of the pelvis.



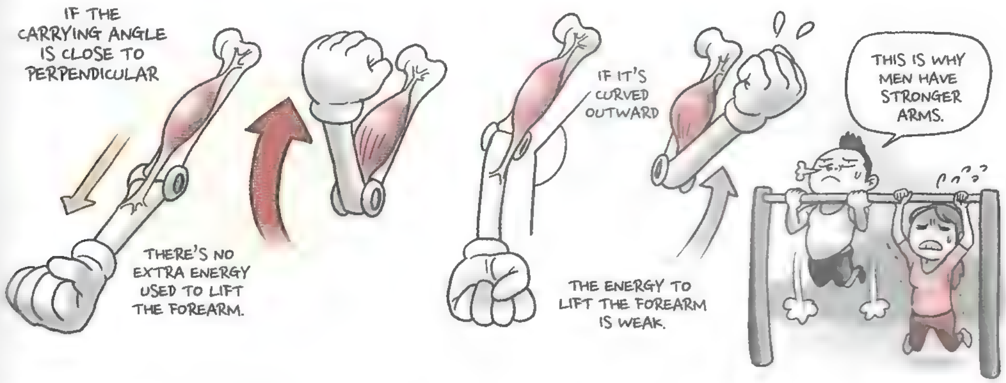
In particular, women's pelvis is wider and bigger than that of the men because women's pelvis is adapted for child bearing. That is why the angle of the ulna and the carrying angle changed according to the curve of the body.



Therefore, although the carrying angle was formed due to the forearm's pronation/supination movement for both genders, the difference in the carrying angle between female and male exists due to the shape of the axial skeleton.



Of course, this experiment doesn't apply to everyone as there's always a difference between individuals. But it applies to people in general. So, do not worry if male readers can do the above position or female readers can't. This variation in the carrying angle between male and female emphasizes the fact that the male body is an inverted triangle shape and that the female body is a triangle shape. Inevitably, the difference in male and female body types has a significant effect on arm strength.

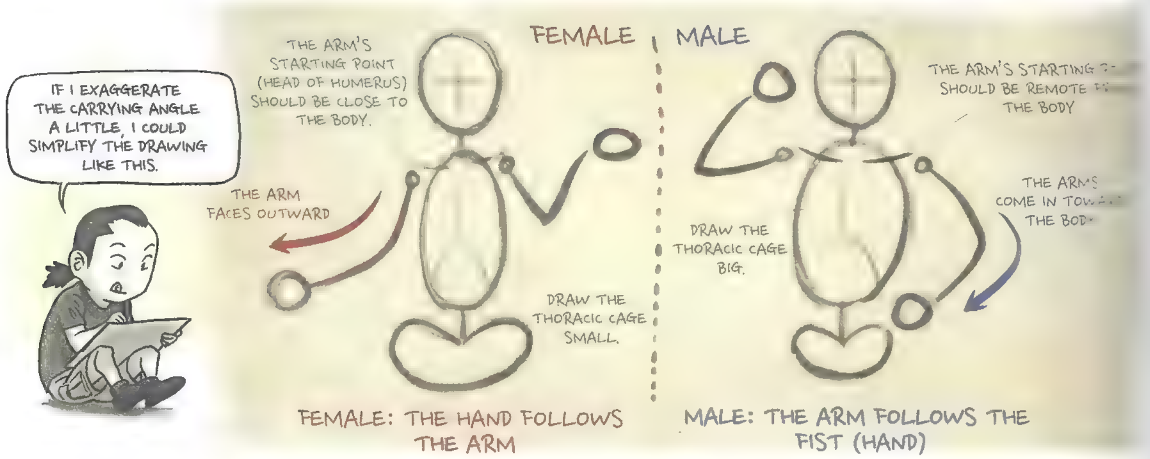


From a mechanical point of view, it is more efficient to lift heavy things with our arms held straight rather than with the arms slightly curved to the side. Therefore, because the angle of the male arm is closer to being perpendicular, men tend to have stronger arms than women.

As a result, men who want to look stronger or women who want to look delicate can use their carrying angle for visual effect.

Obviously, the carrying angle has a significant effect on the body language and culture. You can easily relate to this if you think of how comedians on television imitate the opposite gender.

That being said, those who have a job of visually expressing the human body must be aware of the phenomenon of the carrying angle. If you have understood the characteristic of the carrying angle, you will be able to summarize the visual points in relation to the human anatomy like the following.



Though one thing I'd like to add is that the 'carrying angle,' along with most of the other landmarks on the body, is not the absolute standard for gender classification. There are cases where the opposites apply in real life, so it's hard to generalize it. But the 'carrying angle' was like a secret key for the artists who had to use 'single image' to express men as more masculine and women as more feminine.

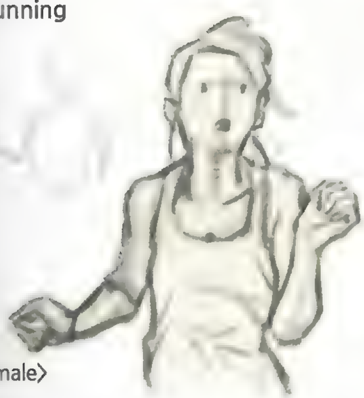
The following examples are typical postures based on gender drawn using the carrying angle Observe the angles in each picture and try observing various circumstances and situations other than these examples.

When posing for a photo

<Female>

<Male>

When running



<Female>

<Male>

When hitting, defending

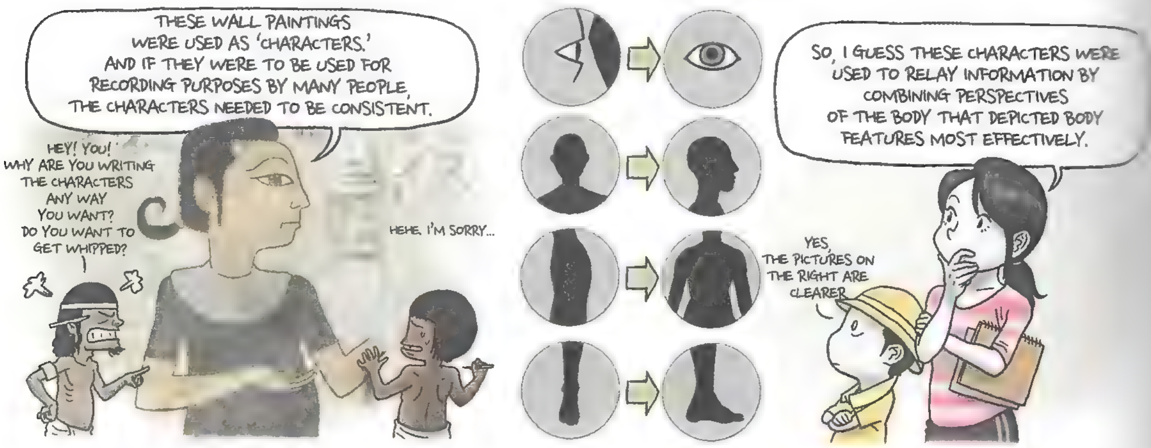
<Female>

<Male>

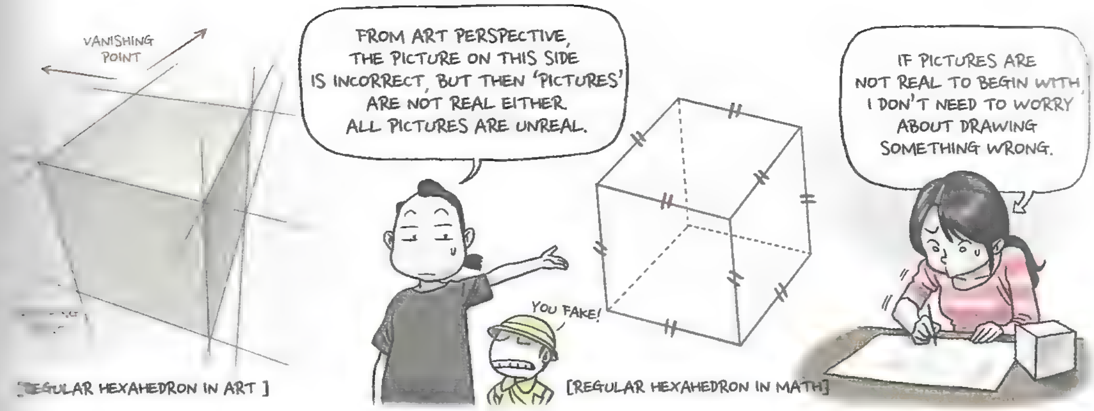
■Let's Draw the Arm Bones

It is once again time to try our hand at drawing. The subtitle of this book is 'For All Those Who Draw.' I am aware that many of the readers are new to drawing. Despite this, I keep on encouraging you to draw, not because I am an illustrator but because drawing is an act of 'recording' first and firstly before being an act of 'art.' Let's take a look at the picture below.

I'm sure that even those unfamiliar with drawing have seen this wall painting. If you take a close look at the characters in the ancient Egyptian wall paintings, the bodies face forward, head and feet are in profile, and eyes face forward. The characters are two-dimensional and do not reflect the actual human body. At first, you might think that ancient people lacked knowledge about the human body but they actually already had the technique to make mummies. Then, why did ancient Egyptians draw their characters in this way?

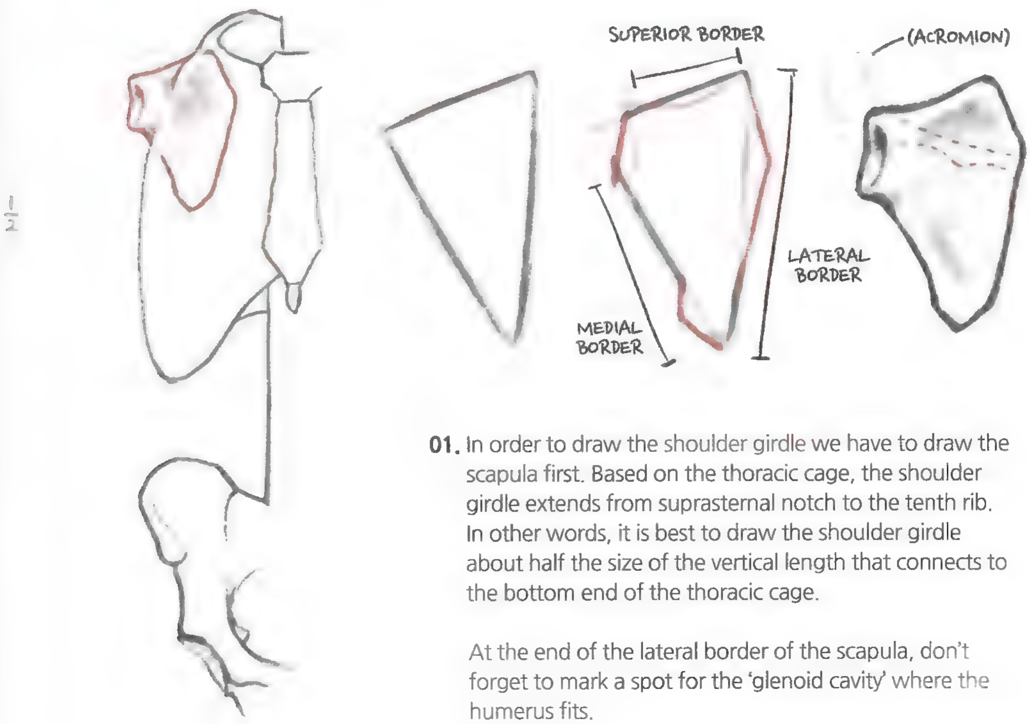


'Law of Frontality' is a drawing technique that depicts the concept rather than the actual shape. An example of this law is Picasso's paintings that show multiple perspectives at the same time. You might have also encountered this concept in math class when you drew a regular hexahedron that ignores perspective to calculate the surface area.



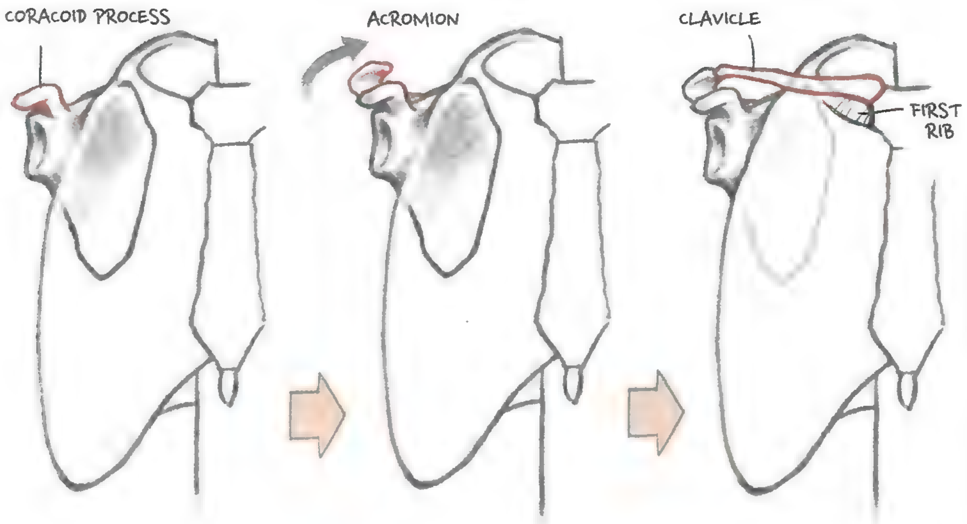
The 'Law of Frontality' comes useful when relaying messages and also for the artist to understand a concept. So, it is not always important to draw something 'accurately and beautifully.' You will feel less pressure while drawing if you think of drawing as a means of recording something that cannot be recorded in letters. We will now draw the arm bone. Don't think of it as drawing a piece of art but drawing for record's sake. So, don't feel pressured and let's begin.

Drawing the Front of the Arm Bones

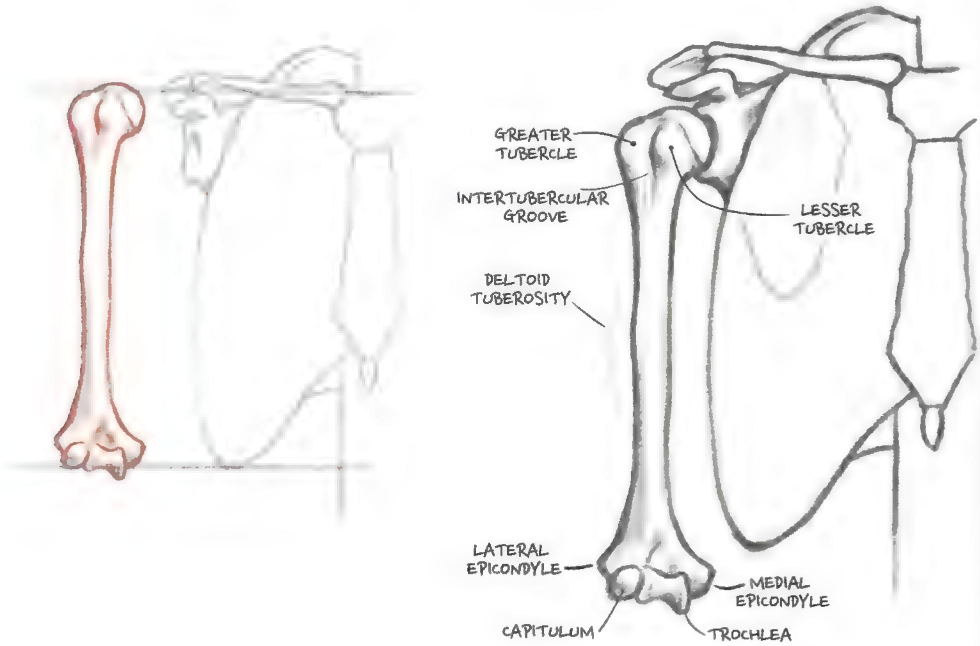


01. In order to draw the shoulder girdle we have to draw the scapula first. Based on the thoracic cage, the shoulder girdle extends from suprasternal notch to the tenth rib. In other words, it is best to draw the shoulder girdle about half the size of the vertical length that connects to the bottom end of the thoracic cage.

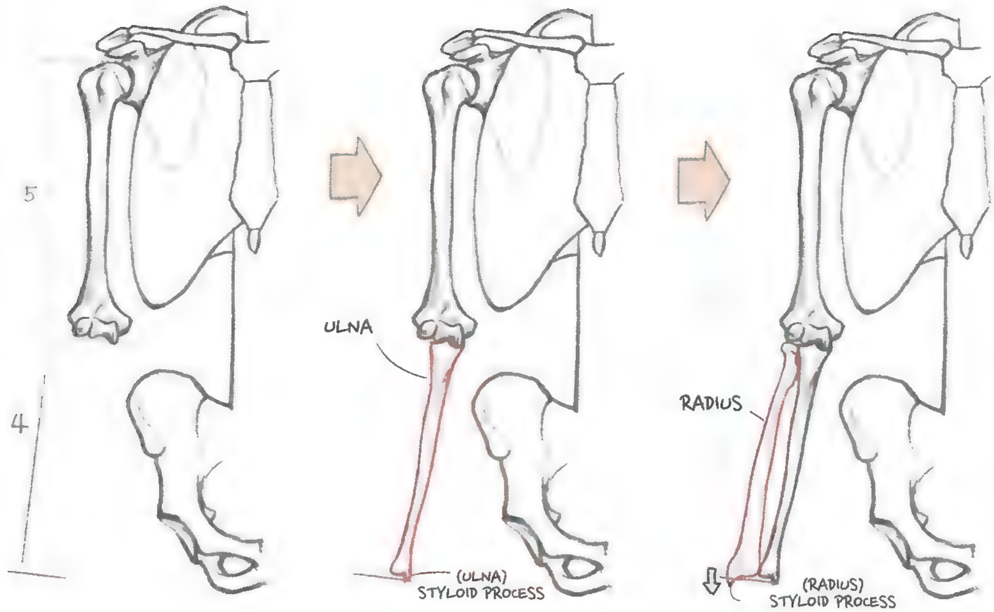
At the end of the lateral border of the scapula, don't forget to mark a spot for the 'glenoid cavity' where the humerus fits.



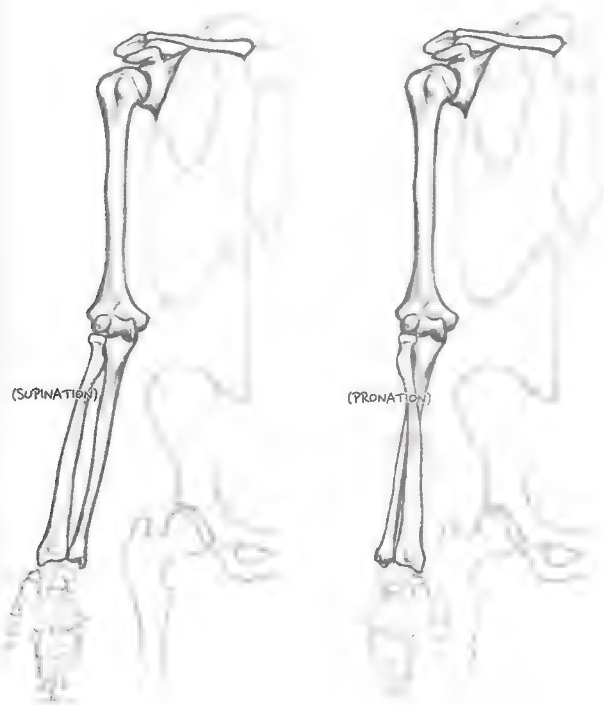
02. Start by drawing a coracoid process, shaped like a bird's beak, just above the 'glenoid cavity.' When you draw the acromion, start from the back of the scapula and then turn toward the front. Then draw the clavicle which connects the manubrium of sternum, and you will have completed the shoulder girdle. Please be mindful of the 'sternum,' the joint where the clavicle and manubrium of sternum meet.



03. Now that the shoulder girdle is ready, it is time to draw the humerus. Based on the thoracic cage, the length of the humerus is similar to the length from suprasternal notch to the tenth rib. Thus, the lower part of the humerus, which is connected to the scapula, is positioned slightly lower than the lower part of the thoracic cage. Remember to check that the medial epicondyle is more protruded than the lateral epicondyle.



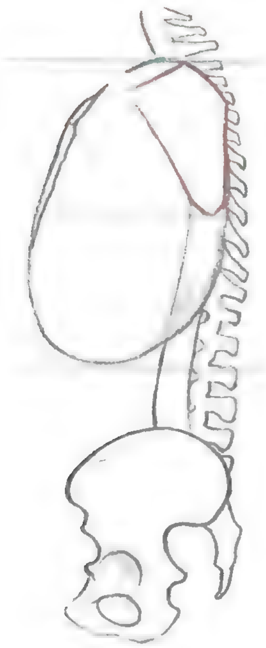
04. This time, let's draw the bone of the forearm. The forearm is made up of two bones and it is slightly shorter than the bone of the upper arm (refer to the picture). First, draw the ulna which allows movements of flexion and extension. Then, draw the radius which allows rotation movements.
In addition, pay attention to the fact that the styloid process of the ulna is lower compared to the styloid process of the radius. It will look more natural if you draw the styloid process slightly outwards due to the angle (carrying angle) between the upper and forearm.

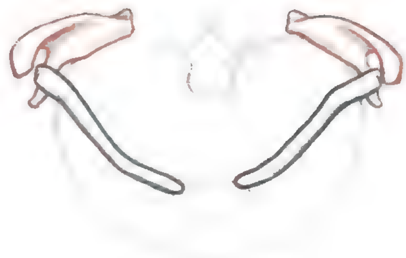


05. This is a complete figure of the arm structure including the hand bones. Let's compare the difference between the carrying angle when the forearm is pronated and when the forearm is supinated.

As a reference, the length of the hand bone reaches about 1/2 of the femur.

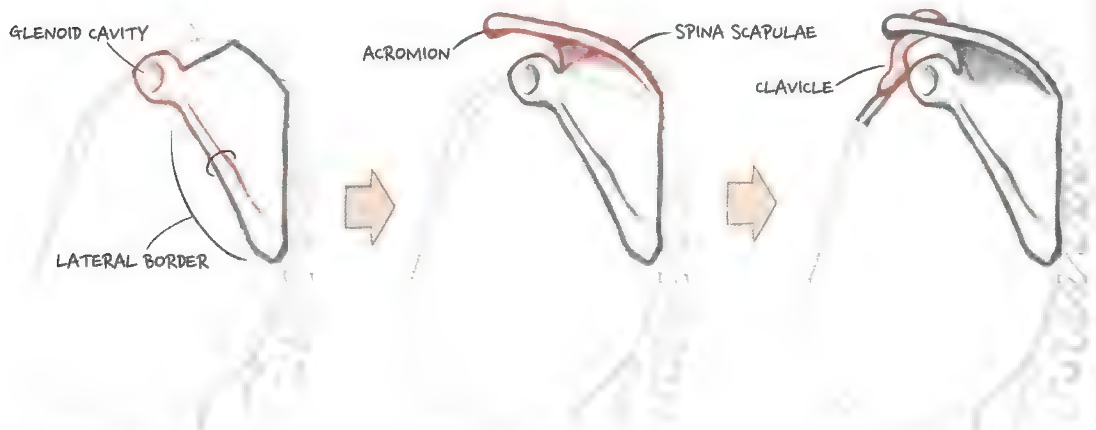
❷Drawing the Side View of Arm Bone



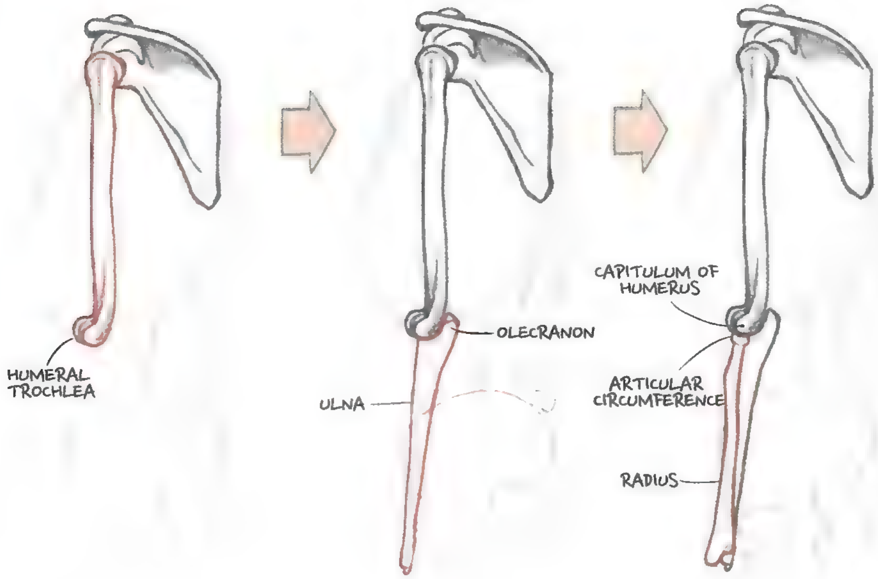


01. Draw the basic shape of the scapula which covers the thoracic cage. It is toward the back of the thoracic cage viewed from the side.

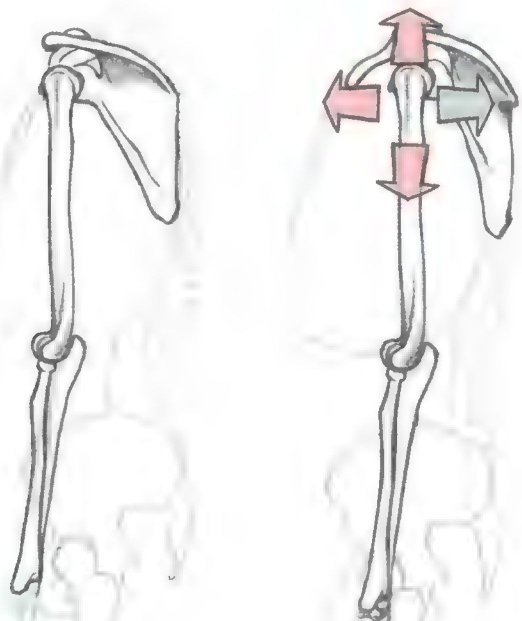
Just like the previous process, the entire height of the scapula should be about half the height of the thoracic cage.



02. Draw the glenoid cavity at the lateral vertex of the clavicle for the head of the humerus. Along the lower side of the glenoid cavity, make sure to illustrate the thickness of the lateral border.
Once that's taken care of, if you draw the spina scapulae as well as the clavicle connected to the spina scapulae, you will be done drawing the 'shoulder girdle.'
As you can see in the last picture, if you sketch a shadow right below the spina scapulae, the protrusion of the spina scapulae will look more vivid.



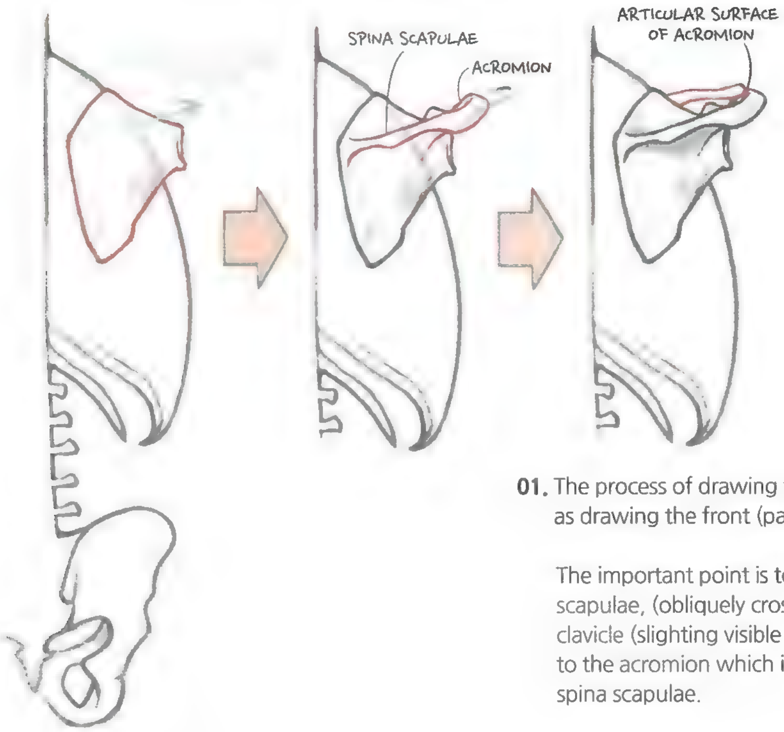
03. First, draw the humerus. The humeral trochlea that connects the forearm at the bottom of the humerus protrudes toward the front. Afterwards, draw the ulna and radius in order. Please pay attention to the point where the olecranon of the ulna is connected to the humeral trochlea. Please also pay attention to the position where the capitulum of humerus connects to the articular circumference of the radius.



04. This is a complete figure of the arm bones, including the hand bones and femur.

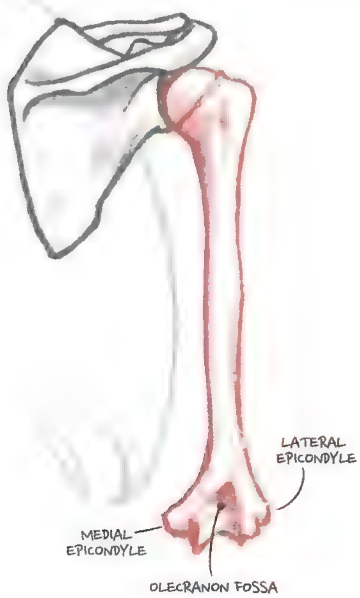
The position of the entire arm depends on the movement of the scapula. Please refer to page 314 to learn more about the movement of the scapula.)

❸ Drawing the Back View of the Arm Bone



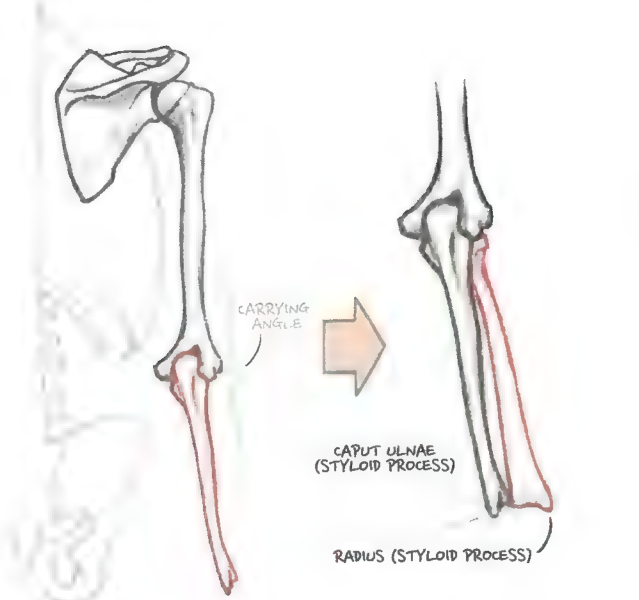
01. The process of drawing the back view is the same as drawing the front (page 343).

The important point is to show that the spina scapulae, (obliquely crossing the scapula), and clavicle (slighting visible in the front) are connected to the acromion which is also connected to the spina scapulae.



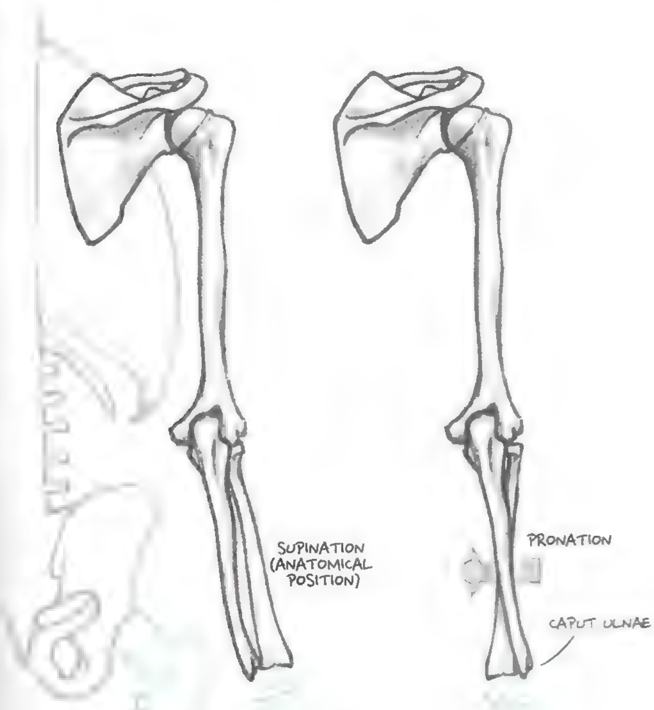
02. Draw the humerus which touches the glenoid cavity of the scapula.

Express a deep triangular depression for the olecranon fossa. Also show the protrusion of the medial epicondyle that is slightly more protruded than the lateral epicondyle.



03. When drawing the forearm, draw the ulna first, then the radius.

Compared to the caput ulnae (the bottom most part of the ulna), the styloid process (the bottommost part of a radius) is lower. Therefore, the range of eversion/inversion movements of the wrist is more restricted on the lateral side than the medial side (refer to page 329).



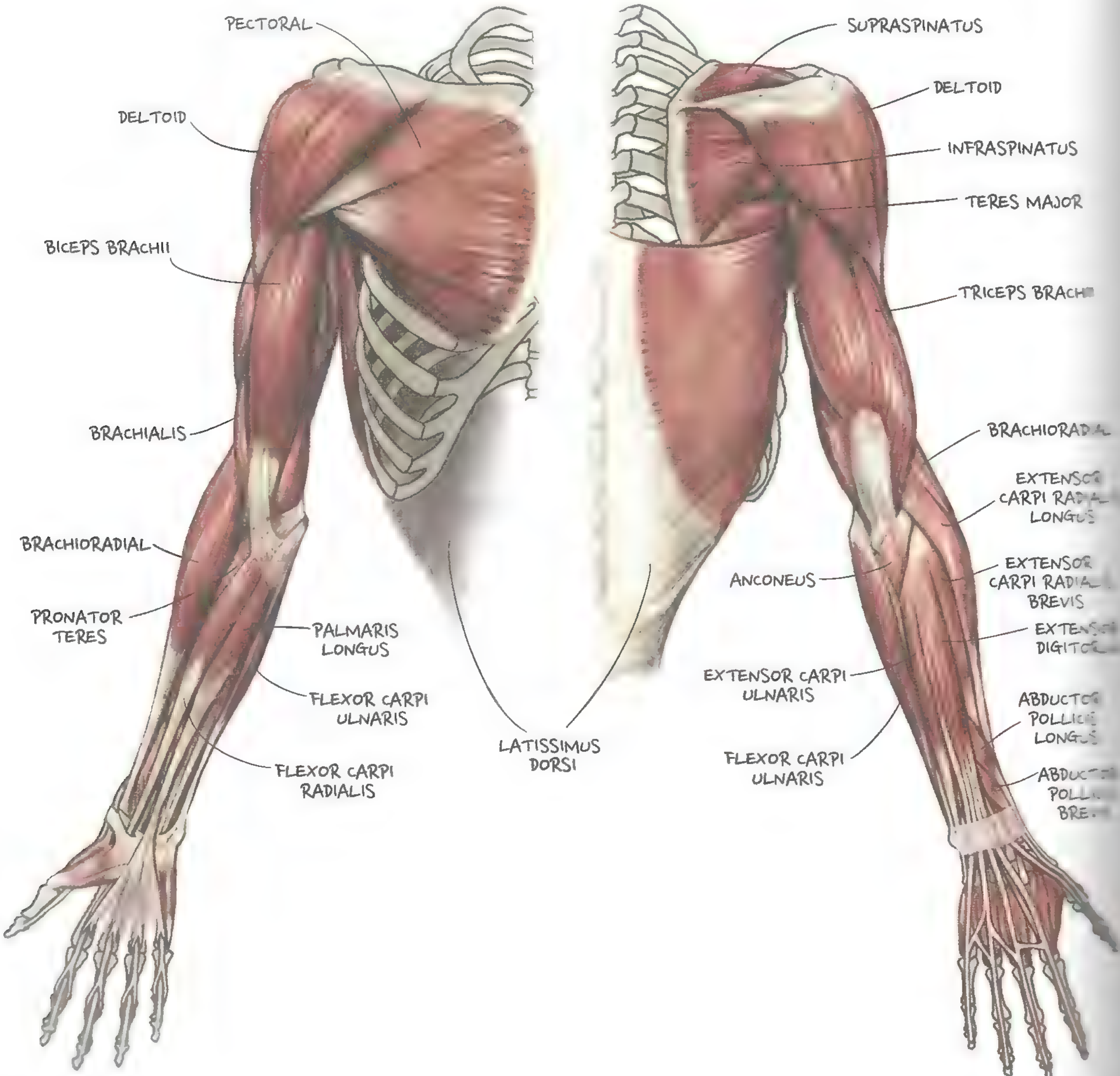
04. The drawing is complete. Just like the front view, let's pay attention to the figure of the forearm and how the radius covers the ulna when it changes from supination to pronation position. Also note that the caput ulnae is relatively more laterally protruded.

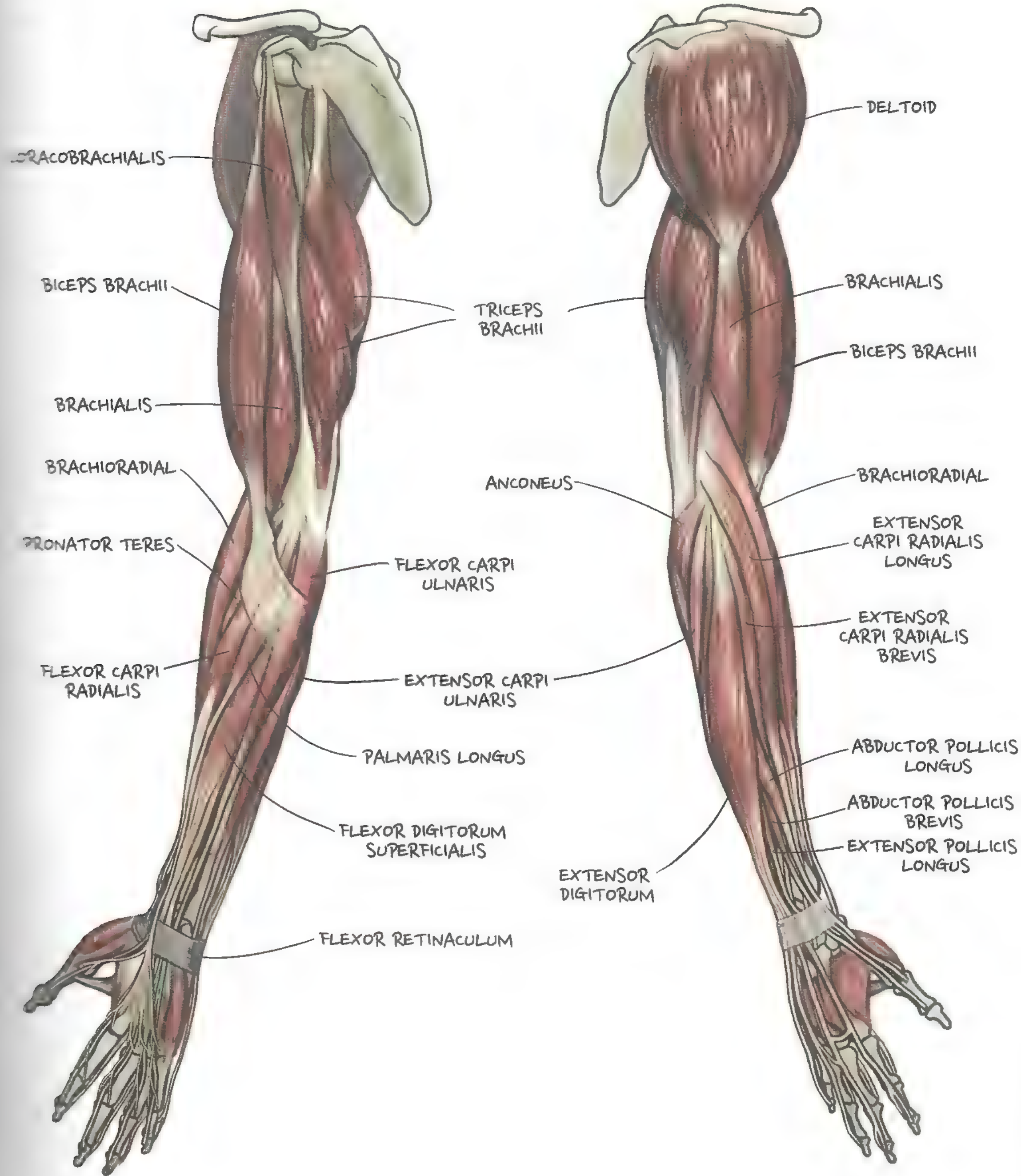
Please refer to the next chapter to learn how to draw the hand bones.

Arm Muscles!

The Figure of the Entire Arm Muscles

These are the names and figures of the arm seen from the front, back, inside and lateral view. It looks complicated since there are many long and thin muscles compared to the wide muscles of the body, but it is not very difficult if you understand the principles. We will delve into each muscle in detail but for now, let's try to match the name, meaning and appearance to each muscle.



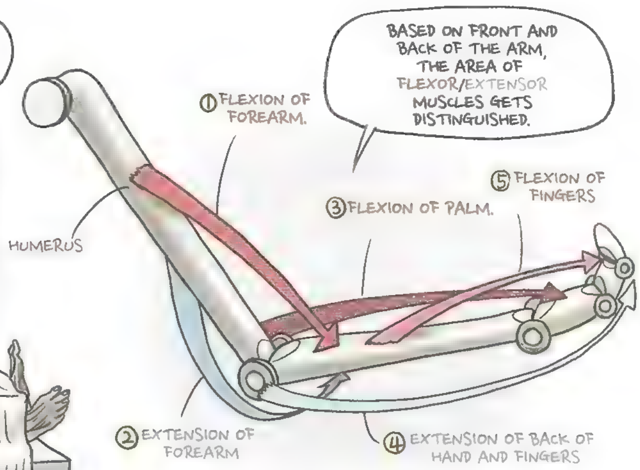

RACOBRACHIALIS
BICEPS BRACHII
BRACHIALIS
BRACHIORADIAL
PRONATOR TERES
FLEXOR CARPI RADIALIS
TRICEPS BRACHII
FLEXOR CARPI ULNARIS
EXTENSOR CARPI ULNARIS
PALMARIS LONGUS
FLEXOR DIGITORUM SUPERFICIALIS
FLEXOR RETINACULUM
DELTOID
BRACHIALIS
BICEPS BRACHII
ANCONEUS
BRACHIORADIAL
EXTENSOR CARPI RADIALIS LONGUS
EXTENSOR CARPI RADIALIS BREVIS
ABDUCTOR POLLICIS LONGUS
ABDUCTOR POLLICIS BREVIS
EXTENSOR POLLICIS LONGUS
EXTENSOR DIGITORUM

■The Image of the Arm

I'm sure that people studying art anatomy are probably most interested in drawing arm muscles. That's because the arms are the second most exposed part of the body after the face and also because the arms play a big part. Usually, when we think of 'muscles,' the first thing that comes to mind are our arms. For these reasons, we have to give much attention to arms when drawing figures.

When I first studied art anatomy at school, I had the hardest time with 'arm muscles.' Since there's a lot of movement involved, there is a lot of joints and muscles which make it more complicated. The worst part is that depending on the forearm's movement (pronation/supination), the shape of the muscles varies. My head was about to burst before my presentation.

Time has passed since, but to be frank, the arm and hand muscles are still confusing to me. I guess it's difficult to fully master them but don't worry too much. While the body's trunk muscles we studied earlier were bigger and wider, making it difficult to guess their functions, the arms are mainly formed by rope-like muscles that drag and pull. As such, it is relatively easier to figure out their movement and function.

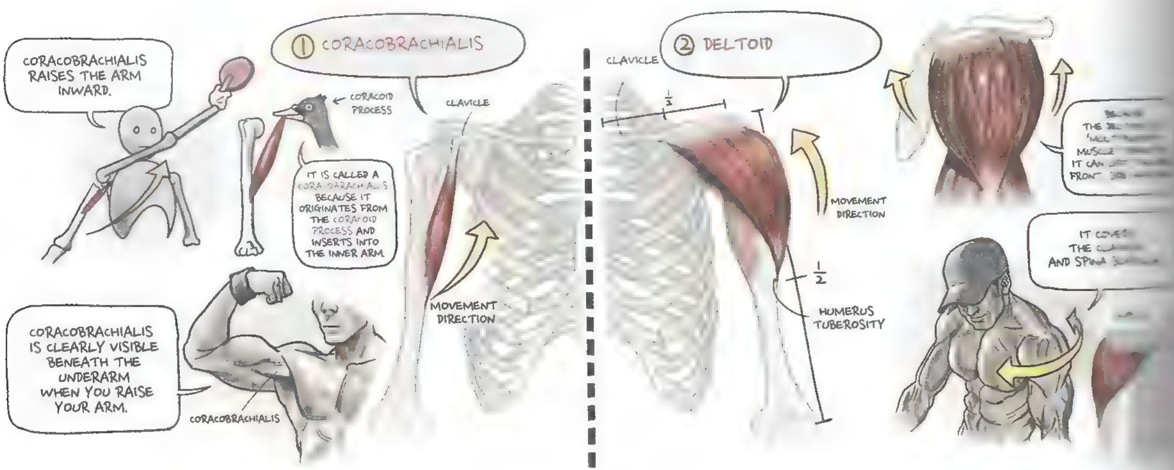


But there's one thing you have to be careful about when studying arm muscles (actually this applies to other parts too). You can't separate the muscles of humerus, forearm and hand. For instance, the muscles in charge of moving our fingers extends to our forearms and hands, and muscles that flex the forearm extend to our humerus and forearm. This is why when studying arm muscles functional classification is the most important point to remember. Even if you don't understand my point, turn to next page.

■Major Muscles of the Arm

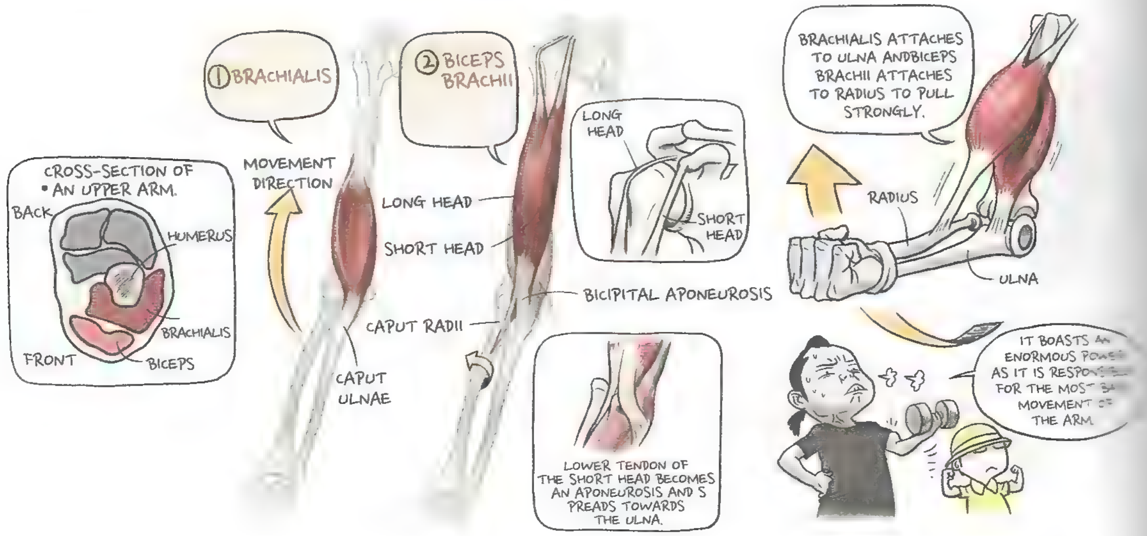
❶ Muscles that lift the entire arm : Deltoid and coracobrachialis

The coracobrachialis is attached to the inner arm starting from the 'coracoid process' on the inner side of scapula. The coracobrachialis muscle is used to rotate the arm internally. The deltoid attaches at the clavicle and spinous process of the scapula. Simply put, the deltoid muscle wraps around the upper arm which allows you to abduct your arm. The coracobrachialis is hidden but is visible beneath the underarm when you raise your arm.

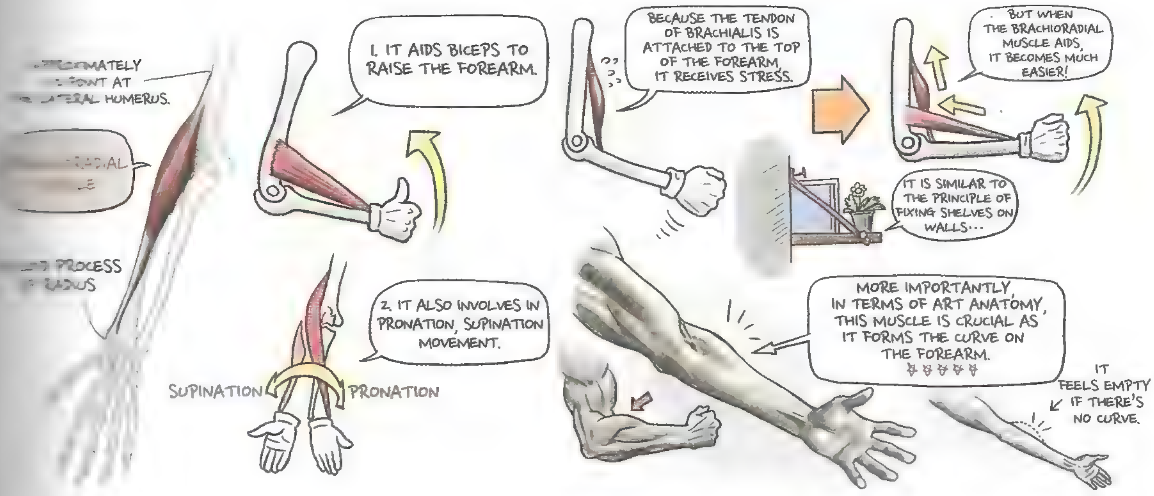


❷ Muscles that flex the entire arm : Brachialis, biceps brachii, brachioradialis

These muscles are not only the strongest but also visually stand out the most because they are responsible for the most basic movement of the arm 'flexion.' The bicep is the most famous muscle as it is called the epitome of muscles. At the same time, it is important to know why this muscle is bifurcated.

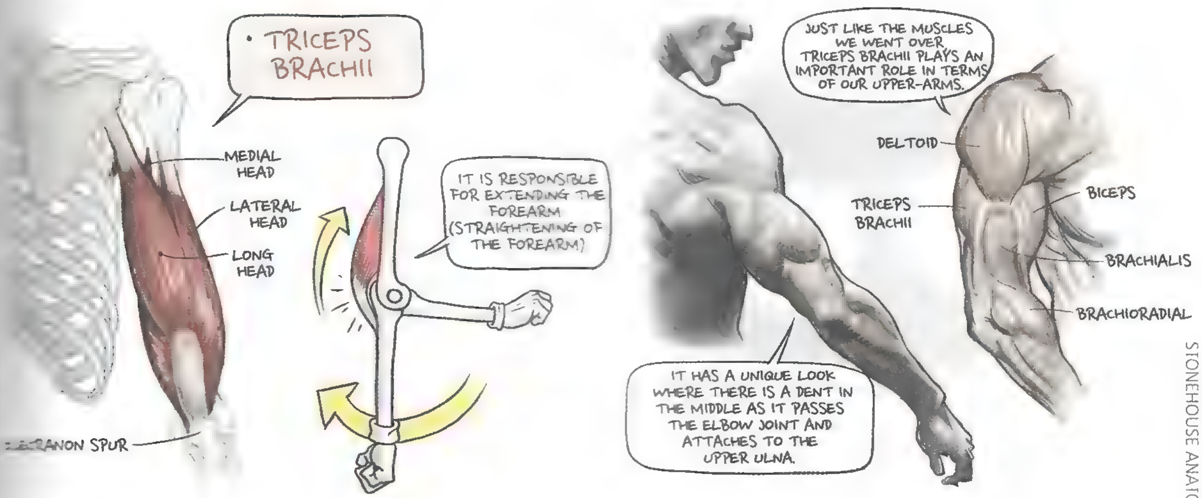


The brachialis and biceps brachii are the muscles that are in charge of raising the forearm, the brachioradialis aids these muscles to flex the forearm at the wrist. This muscle is less known, but it is important when it comes to drawing the arm as it determines the shape of the arm and also the function of this particular muscle is as important as that of the brachialis.



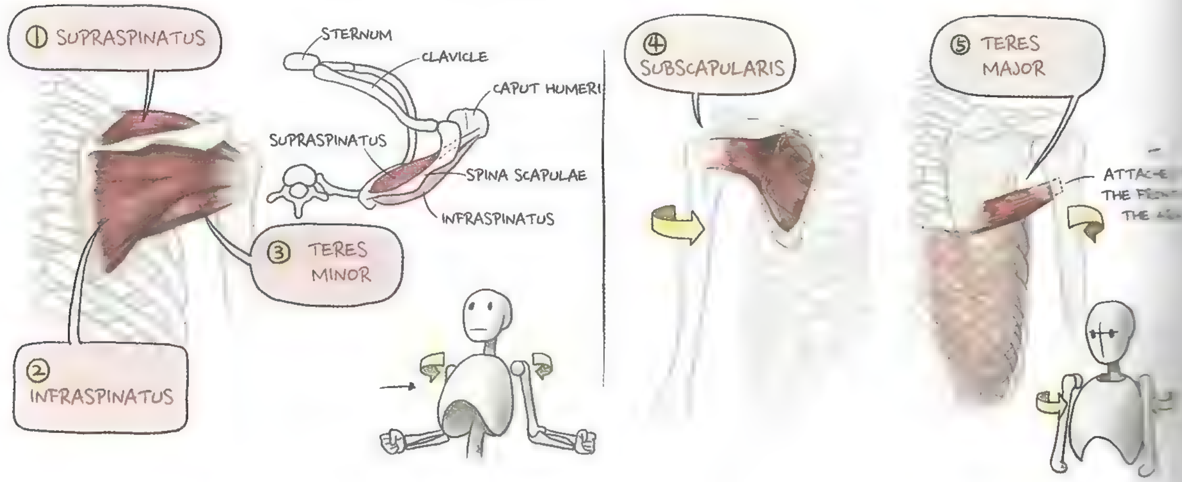
Muscles that extend the entire arm: Triceps brachii

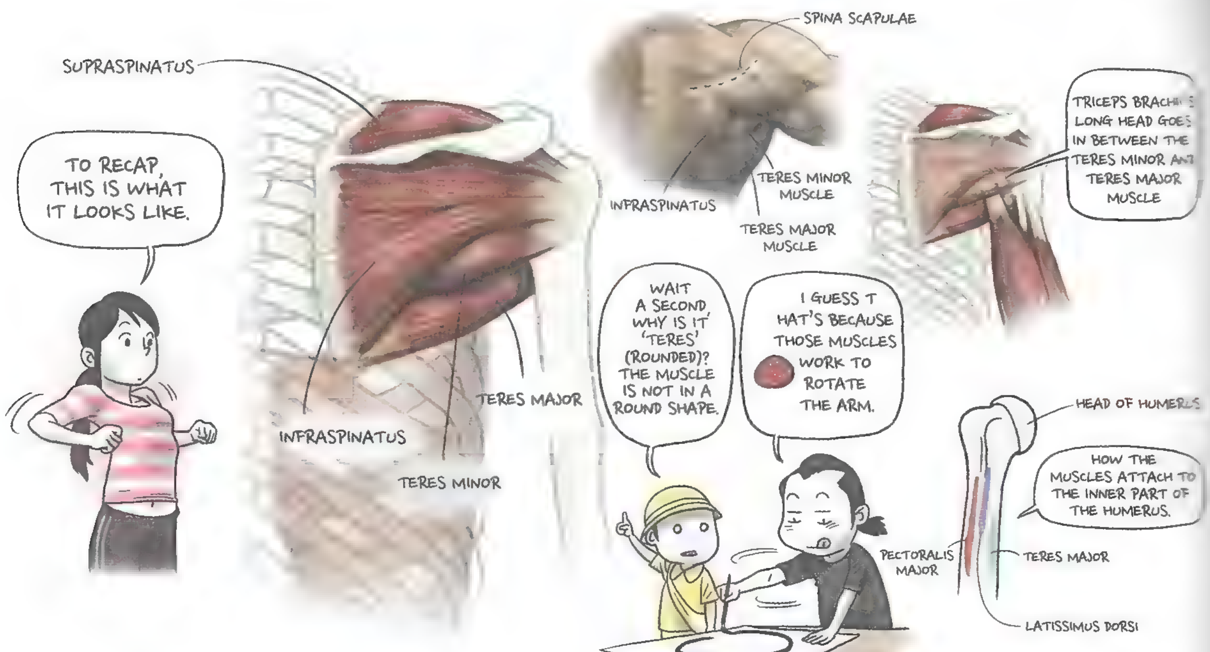
Another really important muscle along with the biceps is the triceps. Contrasting to the function of the muscles explained earlier, it is responsible for extending the arm. No matter how hard is a 'flex' than 'extend,' because this muscle has to handle three muscles alone, this muscle has three origins of support.



❹ Muscles that rotate the entire arm: Supraspinatus, infraspinatus, teres minor, teres major, subscapularis

These muscles are responsible for pulling and pushing the arms back and forth. Based on the location, appearance, and role, these muscles can be categorized as superficial muscles of the back (trapezius, latissimus dorsi). However, because the origin of our arms in the scapula, let's just include these muscles under the category of arm muscles. Of course, these muscles are easily visible in the back of athletes who use their arms a lot.

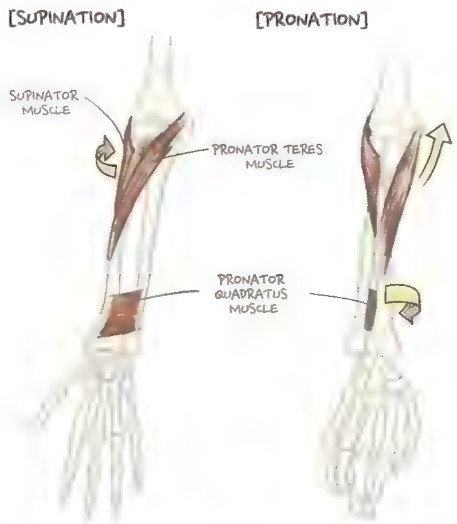




❺ Muscles that rotate the forearm: Pronator teres muscle, Pronator quadratus muscle, supinator muscle

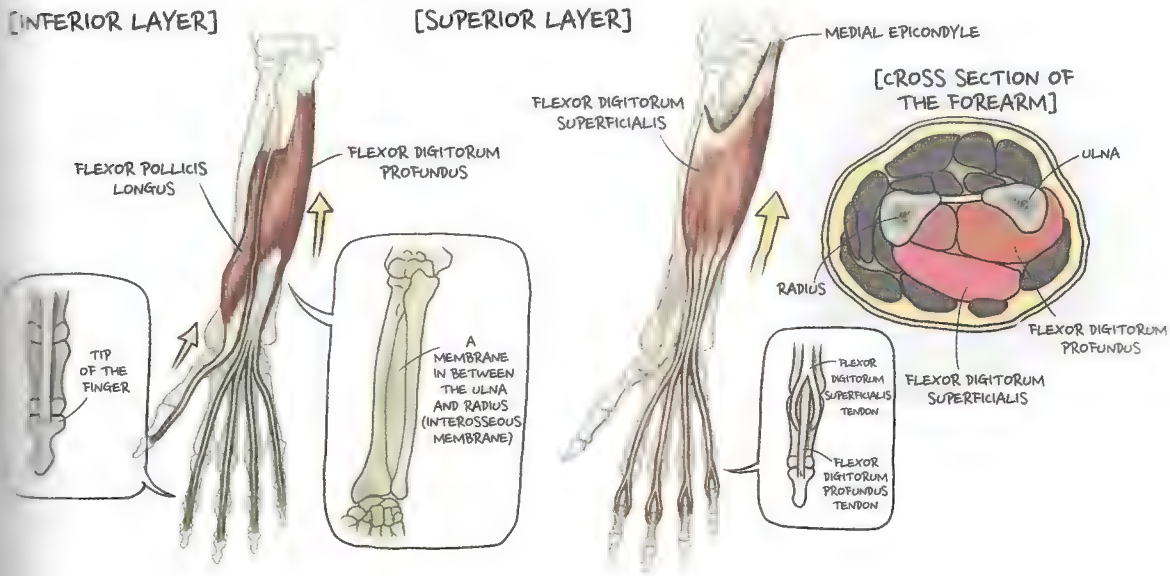
These muscles allow the forearm to do 'pronation/supination.'

It obviously requires more strength to make the ulna and radius overlap in an X-shape (pronation) rather than keeping them parallel in supination position. Therefore, there's only one pronator muscle whereas there are two supinator muscles to perform the movement.



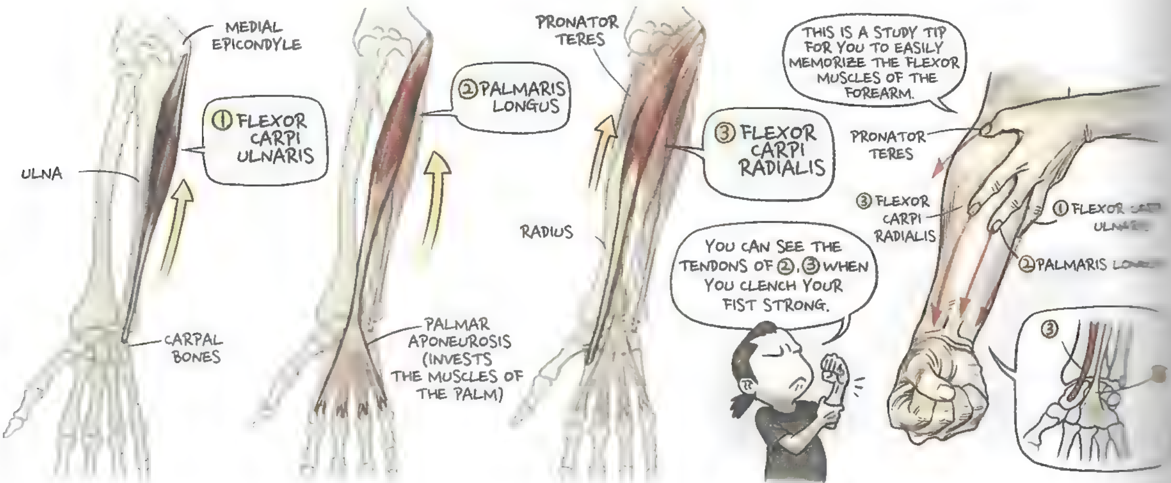
❻ Muscles that flex the fingers: Flexor digitorum profundus, flexor pollicis longus, flexor digitorum superficialis muscle

These muscles are in charge of flexing the fingers but because these muscles are attached to the arms and not the hands, they are called 'extrinsic muscles.' The hand requires enormous strength to grasp things, so the muscles extend to the tip of our fingers as two layered muscles—superior and inferior layer. As these are very powerful muscles, they are thick and wide enough to make up almost half of the muscle in the forearm.



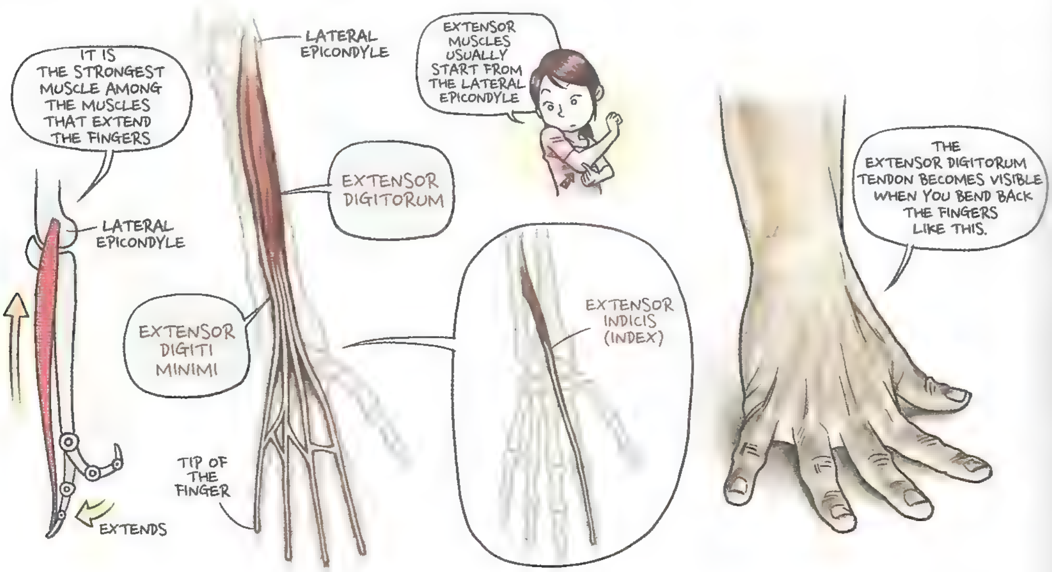
❼ Muscles that flex the wrist: Flexor carpi ulnaris, palmaris longus, flexor carpi radialis

Flexing the wrist requires as much strength as flexing the fingers, so these muscles cover both sides and mid-part of the forearm and stretch to the carpal bones. The attachment points of these three muscles are all different but please bear in mind that these muscles all start from the medial epicondyle of the humerus.



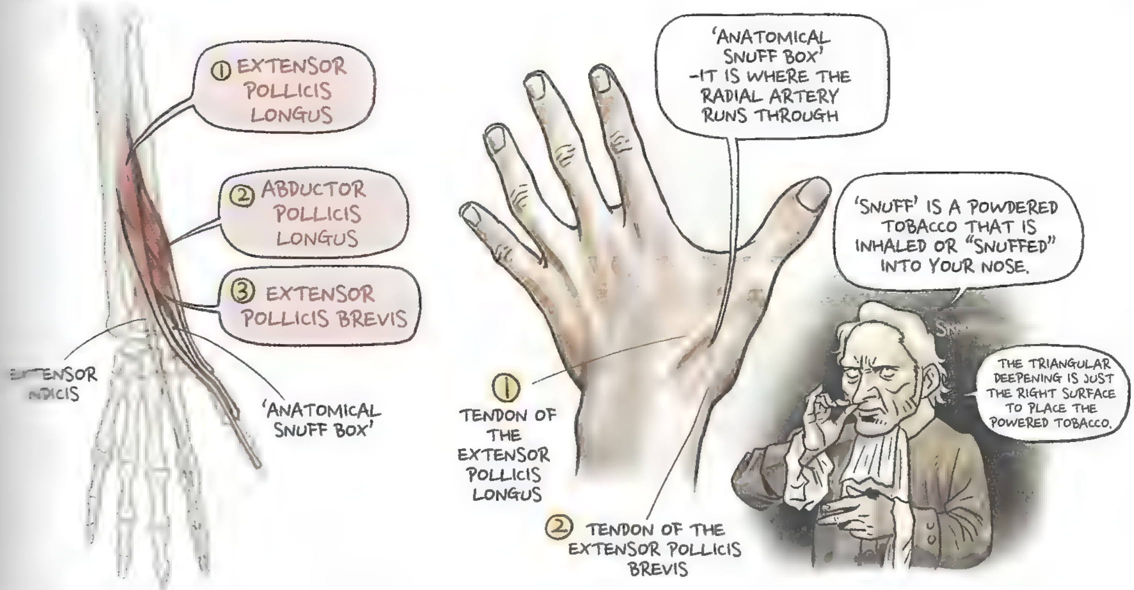
❽ Muscles that extend the fingers: Extensor digitorum, (extensor digiti minimi, extensor indicis)

As mentioned earlier, the flexor muscles of fingers work together as a two-layered muscle. However, it is actually the extensor digitorum that is solely in charge of extending the fingers. Of course, we have the extensor digiti minimi and extensor indicis that extend the little and index fingers respectively, but they are only there to aid the extensor digitorum. It will be enough to just remember the 'extensor digitorum' that becomes visible when you bend back the four fingers.



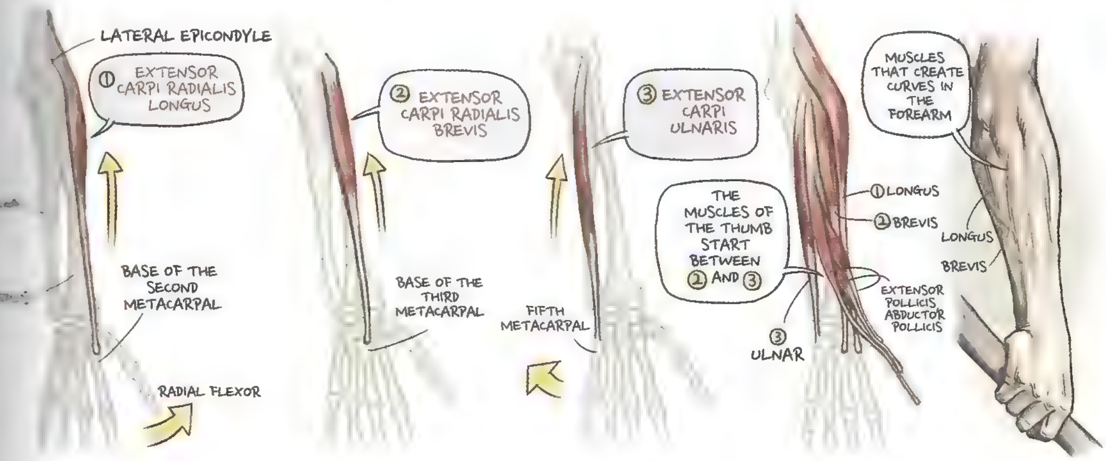
⑨ Muscles that extend the thumb: Extensor pollicis longus, extensor pollicis brevis, abductor pollicis longus

Do you remember how I left out the ‘thumb’ when we studied the phalanges? Our thumb is a special finger so, the muscles that control our thumbs are independent of the extensor digitorum and that makes it special. In particular, the anatomical snuff box formed by the extensor pollicis longus and extensor pollicis brevis is an important milestone on the hand



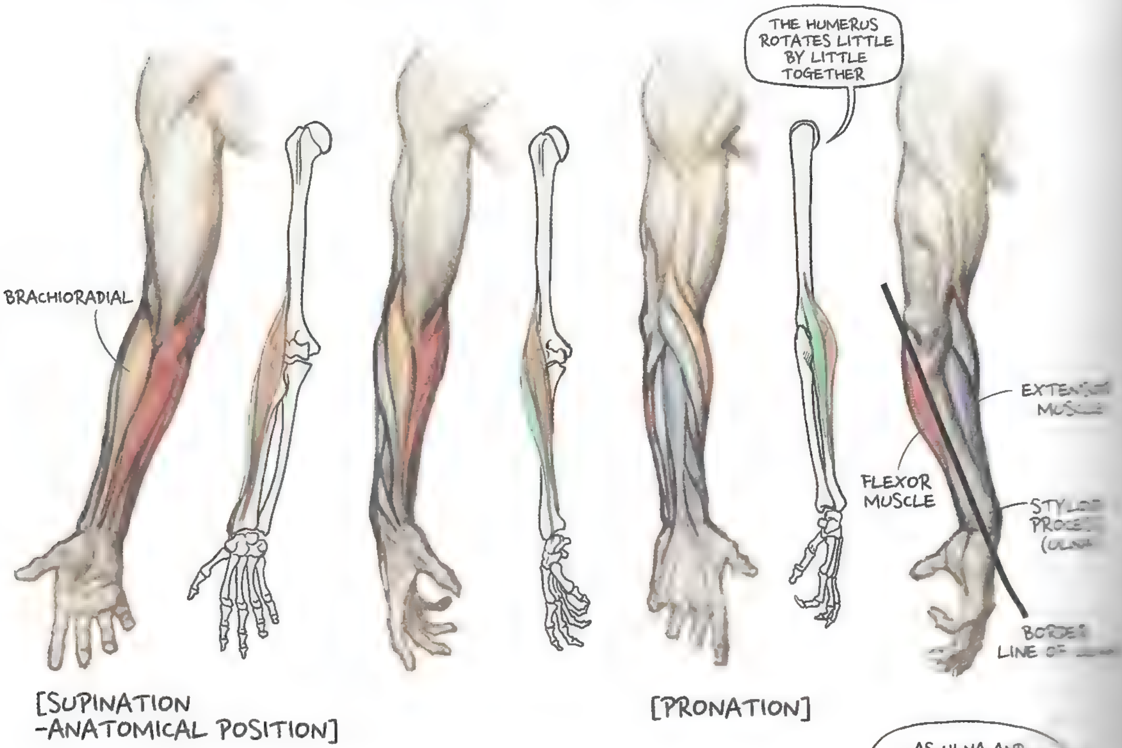
⑩ Muscles that extend the wrist: Extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris

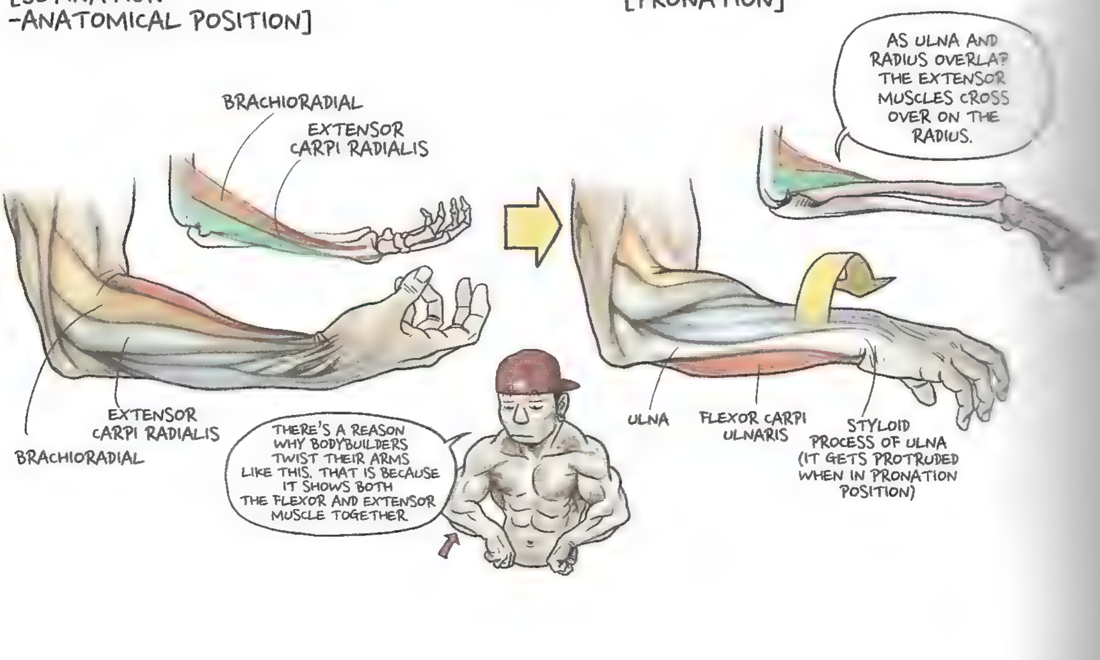
The muscles in charge of flexing the wrist start from the medial epicondyle of the humerus, the muscles in charge of extending the wrist start from the lateral epicondyle and stretch out to the back of the hand. Although it is relatively thinner than flexor muscles, it is more visible in the arms.



Shape of the Arm during Pronation/Supination

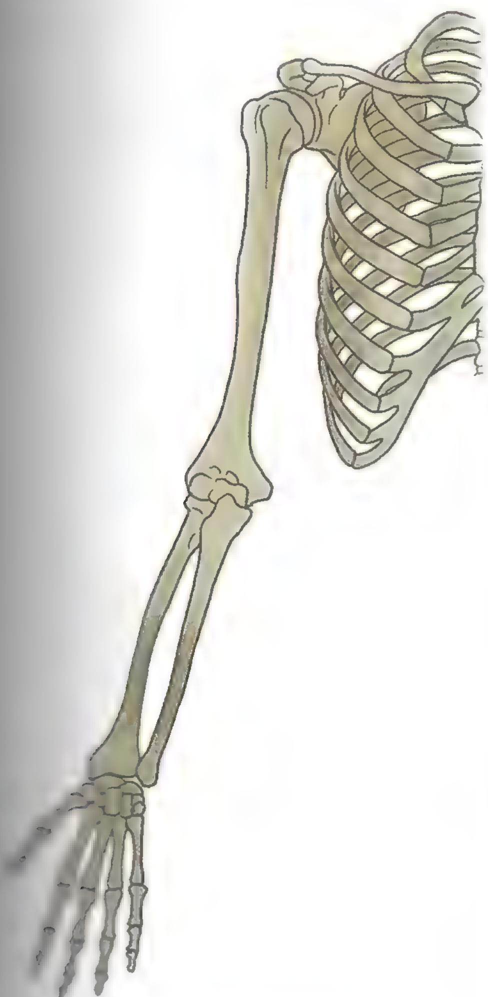
Just like we examined earlier, the forearm's extensor muscles are very visible, so it is very important to observe how those muscles change in shape during pronation/supination. It lo pretty convoluted at first glance, but it is not as complex if you observe based on ulna and brachioradial that are the boundaries of the flexor and extensor muscles.
The shapes below are essential in expressing the arms more effectively, so take a careful





Let's Attach the Arm Muscles

Finally, it is time to attach the arm muscles one by one. Arms and legs consist of long muscles. Thus, it may be easier to understand the functionality of each muscle but it is not easy to understand the overlapping muscles just by looking at a two-dimensional drawing. For that reason, this time, we will take a look at the muscles not only from the front and back but also from the inner and lateral angles. If there are two or more muscles in one picture I will describe the in the order of upper to lower muscles.



• **bones of free upper limb**

01. triceps brachii muscle

02. subscapularis/teres major muscle

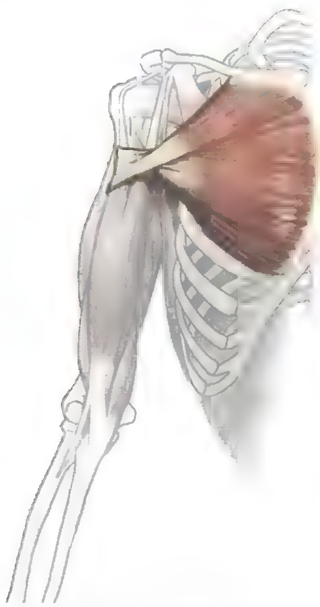
03. latissimus dorsi muscle

04. coracobrachialis muscle

05. pectoralis minor muscle

06. brachialis muscle

07. biceps brachii muscle

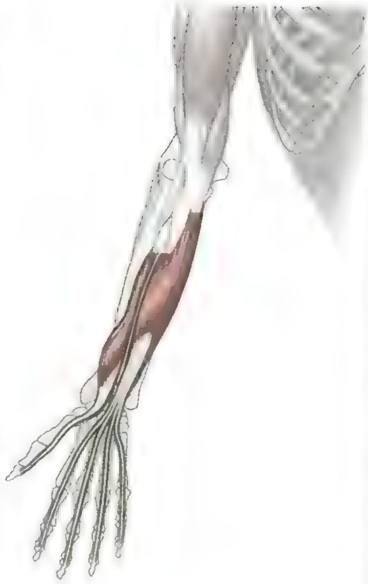


08. pectoralis major muscle

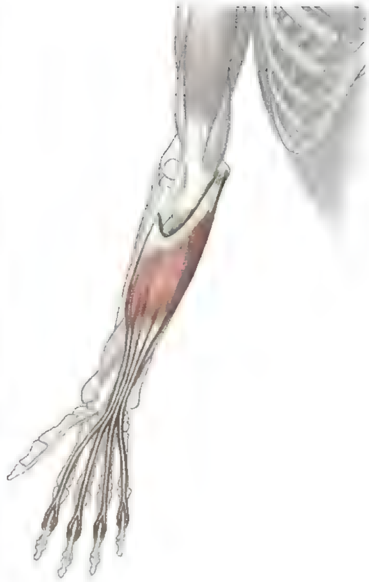
09. Removal of biceps brachii

10. deltoid muscle

11. supinator/pronator quadratus muscle



12. pollicis longus/flexor digitorum profundus muscle

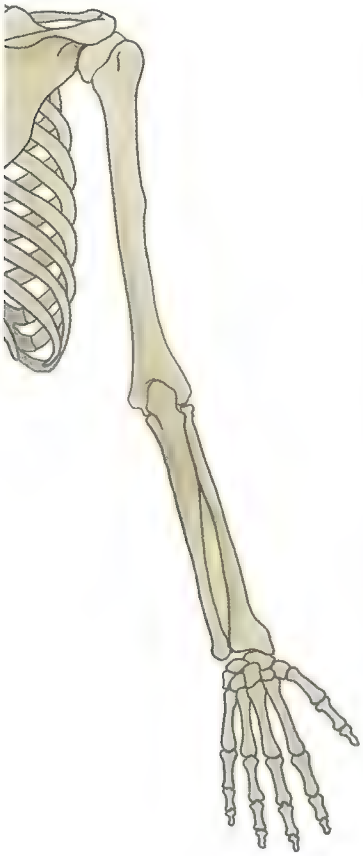


13. flexor digitorum superficialis muscle

14. palmaris longus/flexor carpi ulnaris muscle

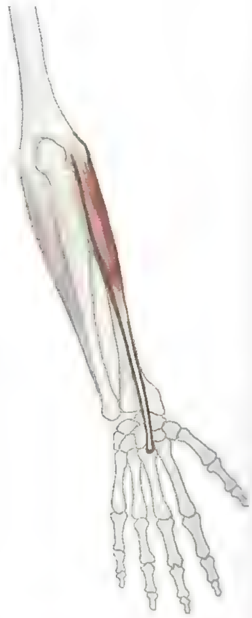
15. pronator teres/flexor carpi radialis muscle

16. Brachioradialis - Completion



❷ Right bone of the free upper limb from the back

01. flexor carpi ulnaris muscle



02. extensor carpi radialis brevis muscle

03. brachioradialis/extensor carpi radialis longus muscle

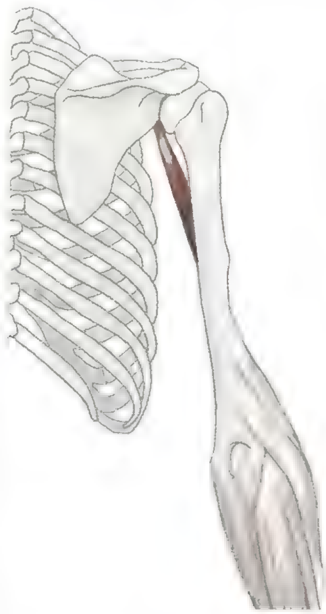
04. Abductor pollicis lon
extensor hallucis brev

05. Extensor indicis, extensor pollicis longus

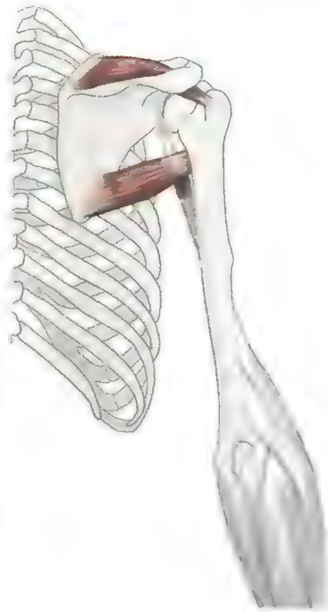
06. extensor digiti minimi/extensor digitorum muscle

07. extensor carpi ulnaris muscle

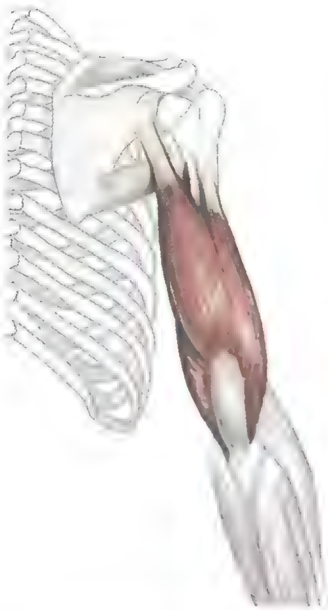
08. anconeus muscle



09. coracobrachialis muscle

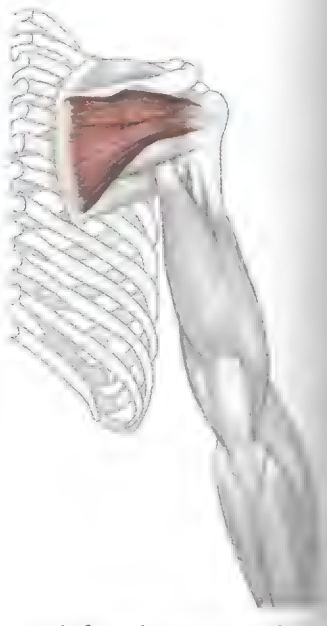


10. supraspinatus/ teres major muscle



11. triceps brachii muscle

12. teres minor muscle

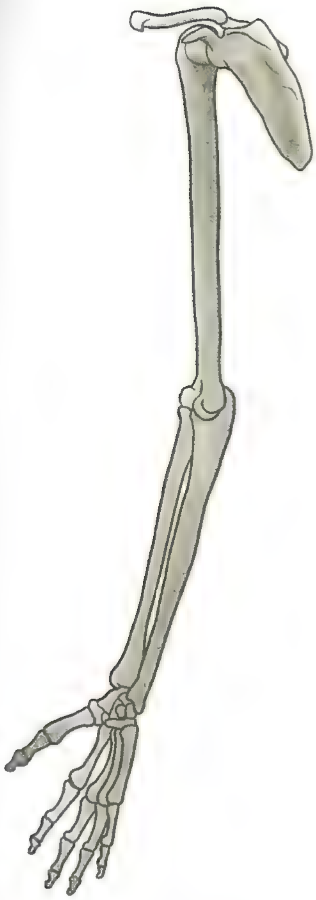


13. infraspinatus muscle

14. deltoid muscle

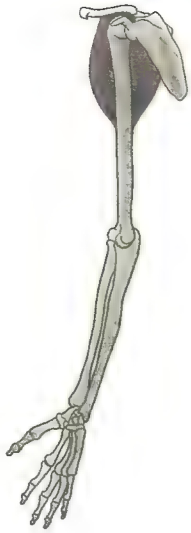
15. latissimus dorsi muscle

16. Completion

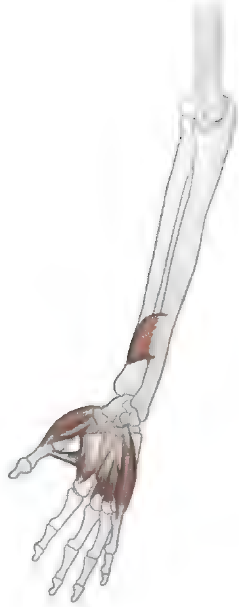


❸ Right bone of the free upper limb from the inside

From here, let's try to attach muscles from the inner side of arms to outside in order. This is not the usual 'front and back' point of view and because both of the flexor and extensor muscles are visible people studying art anatomy for the first time might get confused. So, if you aren't familiar with the arm muscles you can move on to the next page.



01. deltoid muscle



02. pronator quadratus muscle

03. extensor carpi radialis longus muscle

04. brachioradialis muscle

05. pronator teres muscle

06. flexor pollicis longus muscle

07. extensor digitorum muscle

08. extensor carpi ulnaris muscle

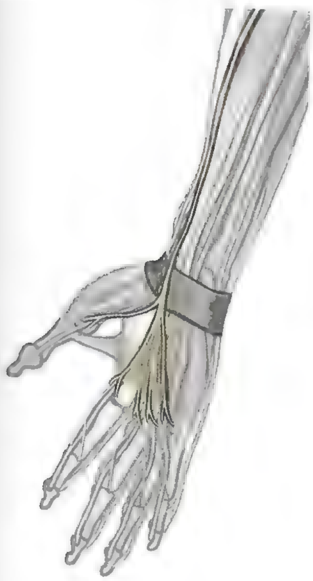
09. flexor digitorum profundus muscle

10. flexor digitorum superficialis muscle

11. flexor carpi ulnaris muscle

12. flexor carpi radialis muscle

13. palmaris longus muscle

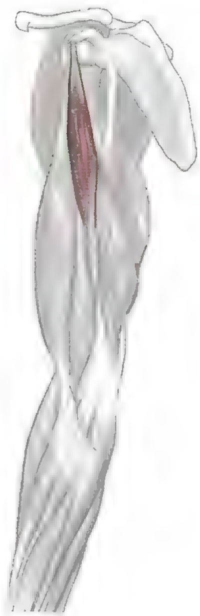


14. flexor retinaculum

15. brachialis muscle

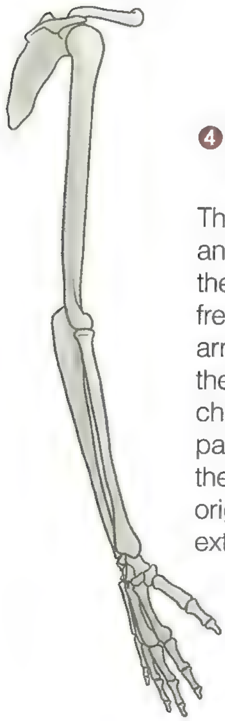
16. triceps brachii muscle

17. biceps brachii muscle



18. coracobrachialis muscle

19. Completion of inner arm



❹ Right bone of free upper limb from the lateral side

This is probably the most difficult and confusing part to draw. On the other hand, this angle is frequently used when drawing the arm. If you've only tried drawing the muscles until now, you can challenge yourself to draw this part as well. In terms of drawing the forearm, understanding the originating points flexor and extensor muscle is the key..

01. Flexor digitorum profundus, flexor carpi radialis

(page 437)

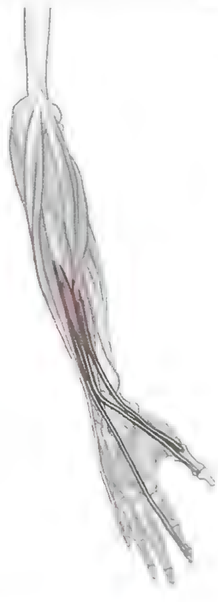
02. Flexor carpi ulnaris, anconeus

03. Flexor carpi ulnaris, anconeus

04. Supinator

05. Extensor carpi ulnaris, pronator teres

06. extensor digiti minimi/ extensor carpi radialis brevis m.



07. Extensor indicis, extensor pollicis brevis, extensor pollicis longus

08. Abductor pollicis longus

09. Extensor digitorum

10. Brachialis

11. Biceps brachii

12. Extensor carpi radialis longus

13. Brachioradialis

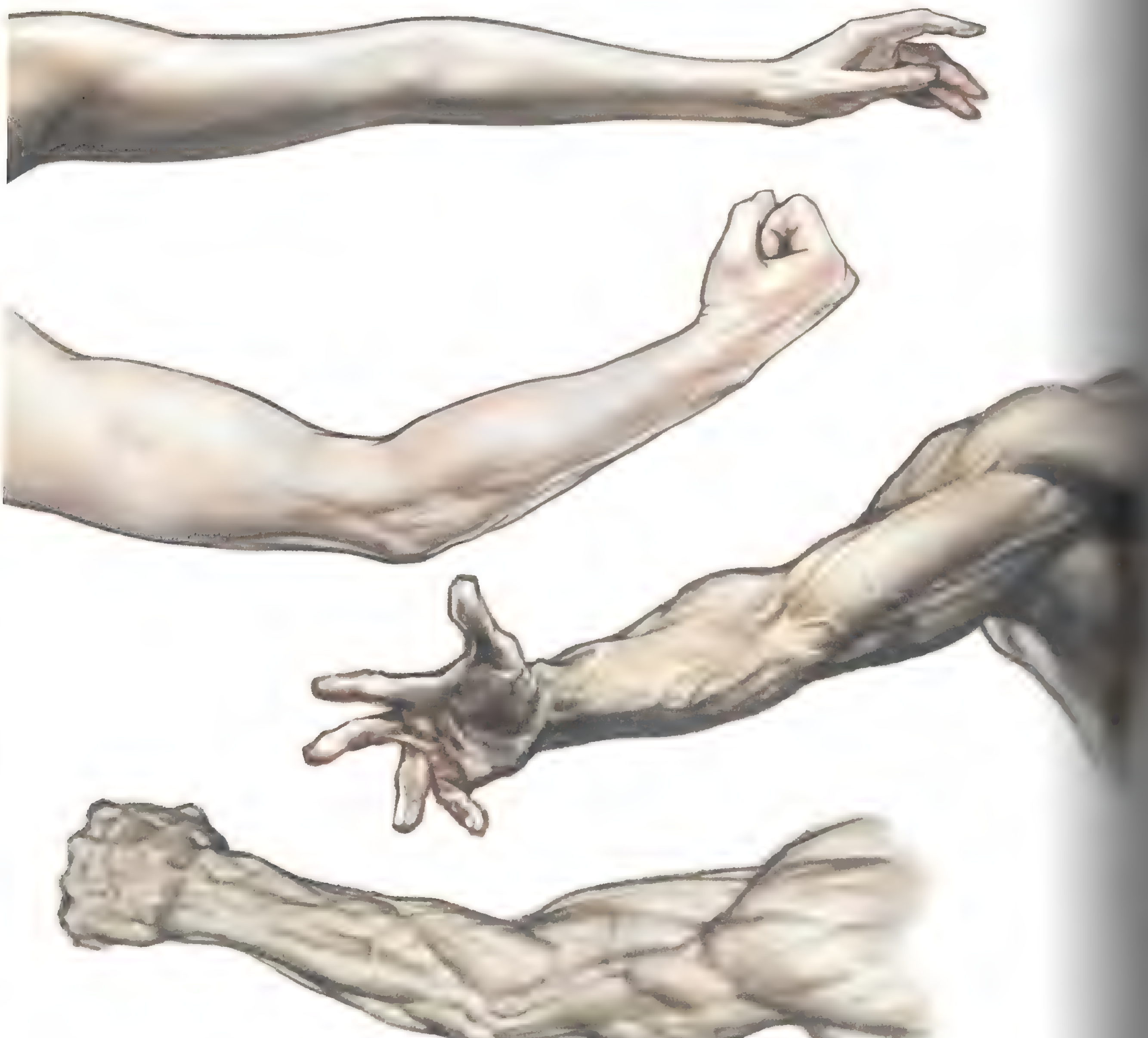
14. riceps brachii

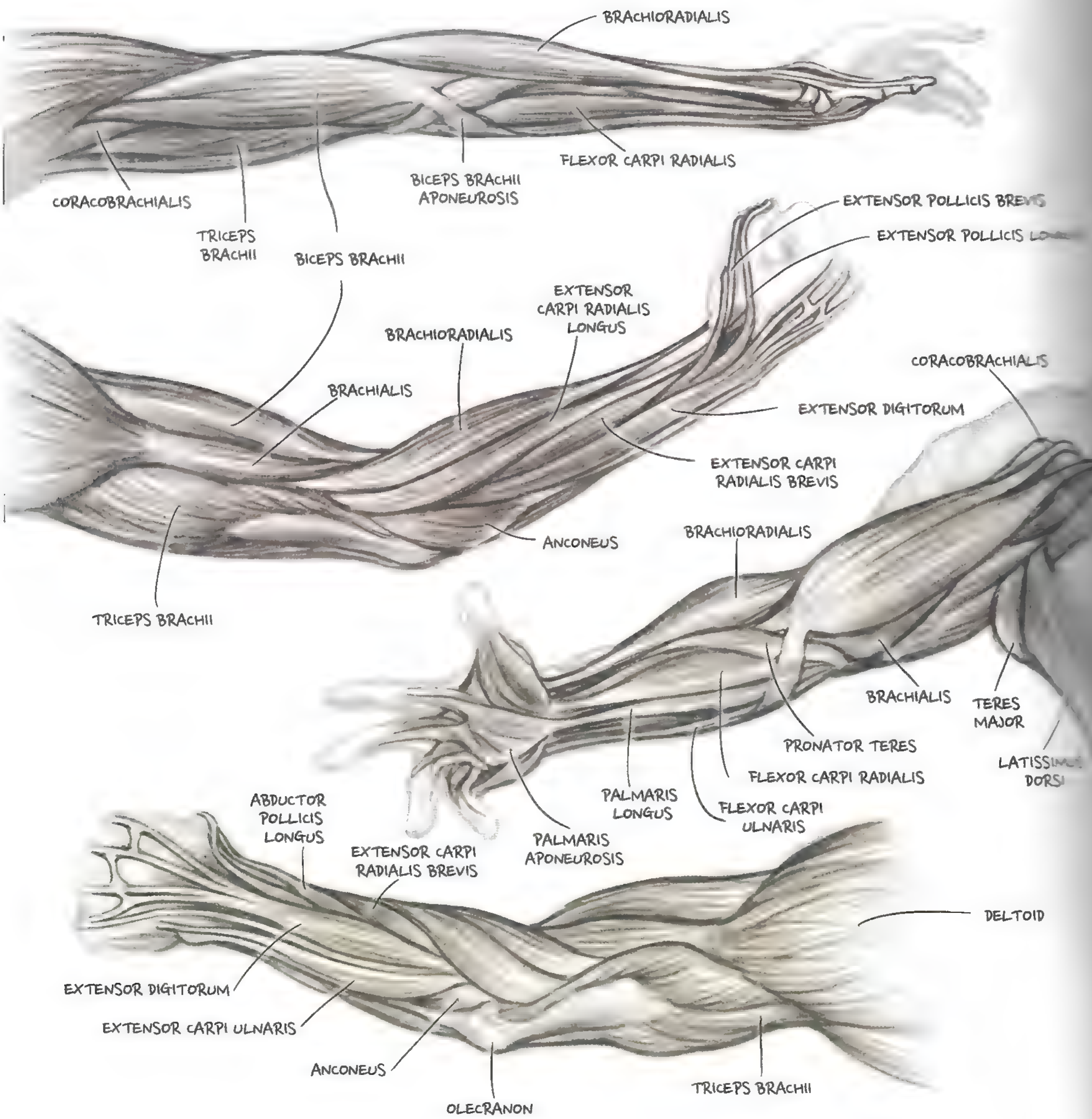
15. Deltoid

16. Completion of the arm from the lateral side.

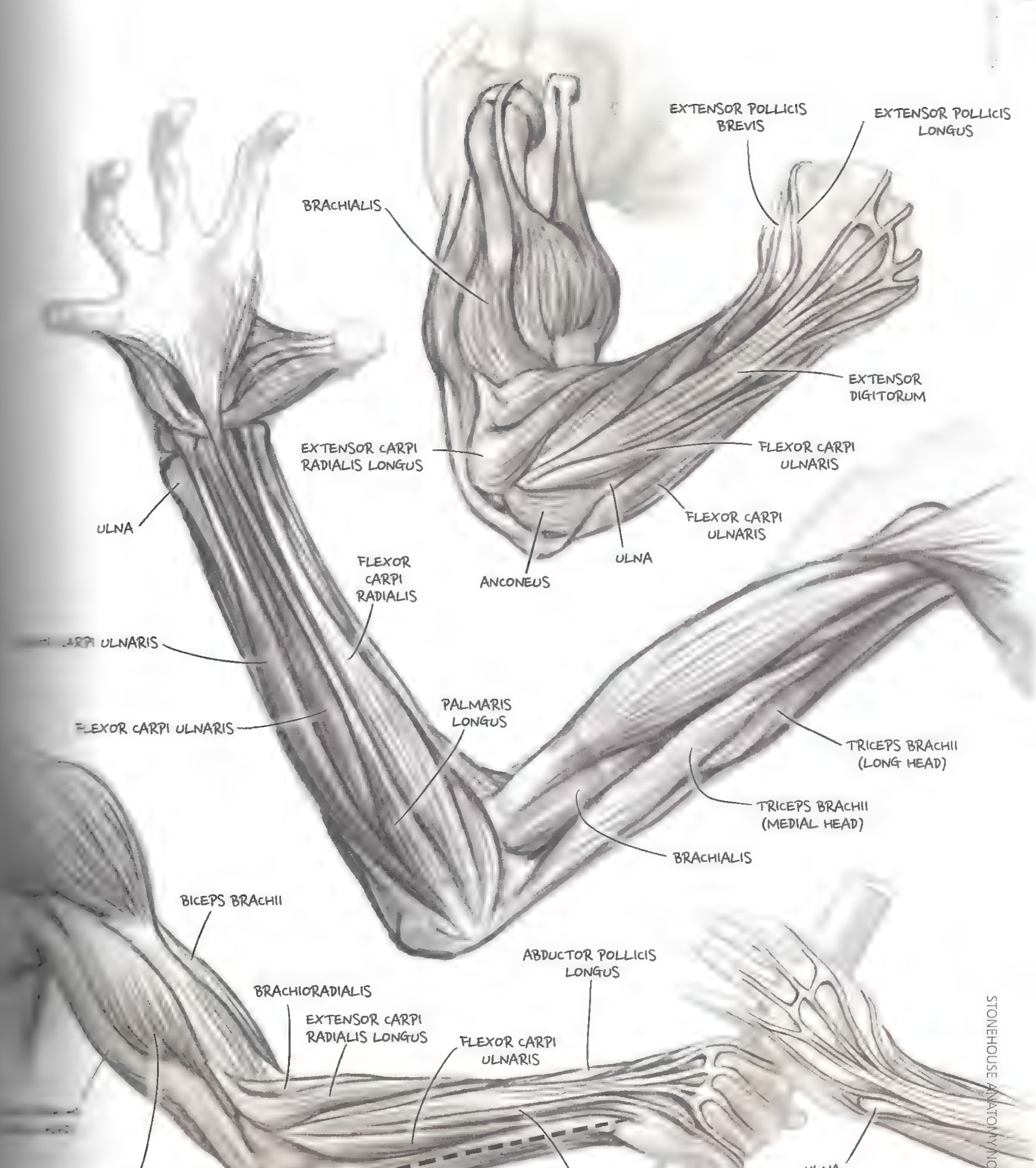
Different Figures of the Arms

Below are different depictions of arms. As the arms become more developed, the veins are pus closer to the skin, making the arms look more complicated. For now, only examine the muscles will explain more about the veins later (page 623). The veins, in anatomical drawing at least, are mere decorations.





BRACHIORADIALIS
FLEXOR CARPI RADIALIS
BICEPS BRACHII APONEUROSIS
CORACOBRACHIALIS
TRICEPS BRACHII
BICEPS BRACHII
EXTENSOR POLLICIS BREVIS
EXTENSOR POLLICIS
EXTENSOR CARPI RADIALIS LONGUS
BRACHIORADIALIS
BRACHIALIS
EXTENSOR DIGITORUM
EXTENSOR CARPI RADIALIS BREVIS
ANCONEUS
TRICEPS BRACHII
CORACOBRACHIALIS
BRACHIORADIALIS
BRACHIALIS
TERES MAJOR
PRONATOR TERES
FLEXOR CARPI RADIALIS
LATISSIMUS DORSI
PALMARIS LONGUS
FLEXOR CARPI ULNARIS
PALMARIS APONEUROSIS
ABDUCTOR POLLICIS LONGUS
EXTENSOR CARPI RADIALIS BREVIS
DELTOID
EXTENSOR DIGITORUM
EXTENSOR CARPI ULNARIS
ANCONEUS
TRICEPS BRACHII
OLECRANON

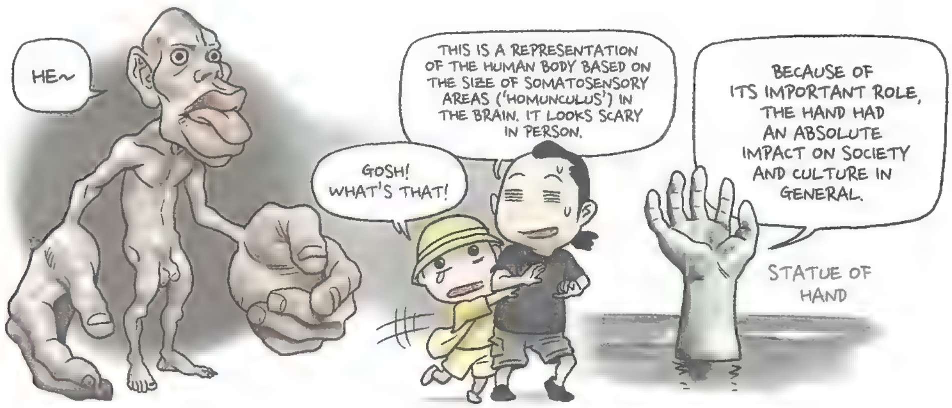

EXTENSOR POLLICIS BREVIS
EXTENSOR POLLICIS LONGUS
BRACHIALIS
EXTENSOR DIGITORUM
EXTENSOR CARPI RADIALIS LONGUS
FLEXOR CARPI ULNARIS
FLEXOR CARPI ULNARIS
ULNA
ANCONEUS
ULNA
FLEXOR CARPI RADIALIS
ARPI ULNARIS
LEXOR CARPI ULNARIS
PALMARIS LONGUS
TRICEPS BRACHII (LONG HEAD)
TRICEPS BRACHII (MEDIAL HEAD)
BRACHIALIS
BICEPS BRACHII
ABDUCTOR POLLICIS LONGUS
BRACHIORADIALIS
EXTENSOR CARPI RADIALIS LONGUS
FLEXOR CARPI ULNARIS
ULNA
CEPS BRACHII
TERAL HEAD)
ULNA
FLEXOR CARPI ULNARIS
EXTENSOR DIGITORUM (EXTENSOR DIGITI MINIMI)

Put Your Hands Up

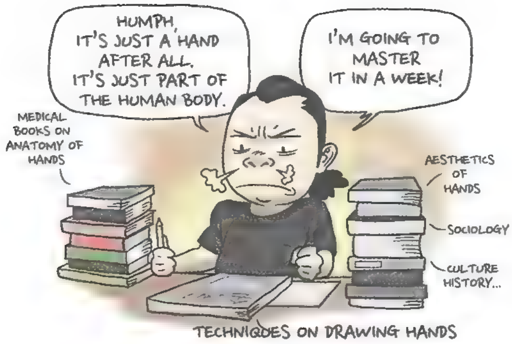
■Do You Want Me to Read Your Palm?

Finally, it is now time to talk about the 'hand.'
While writing this book, I was worried, thrilled and nervous about the hand chapter.
I also put in the most thought into this chapter.

As I mentioned briefly in the introduction, our 'hands' were the biggest driving force behind building the human civilization. Hands not only have numerous social, cultural and artistic symbols and stories, but they are also very important in terms of medical and physiological developments. They are essential because they inform a lot of our senses (input) and inform our coping behaviors (output) for our brain.

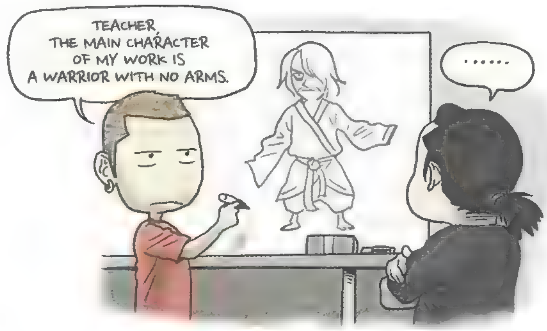


As this is the case, I will not be able to cover everything about the 'hand' in just one book. Even if I were to write an outline, I would not know where to start because there's too much to cover. Fortunately, this book only covers the 'appearance' of the hand. Although, that is no easy task either.

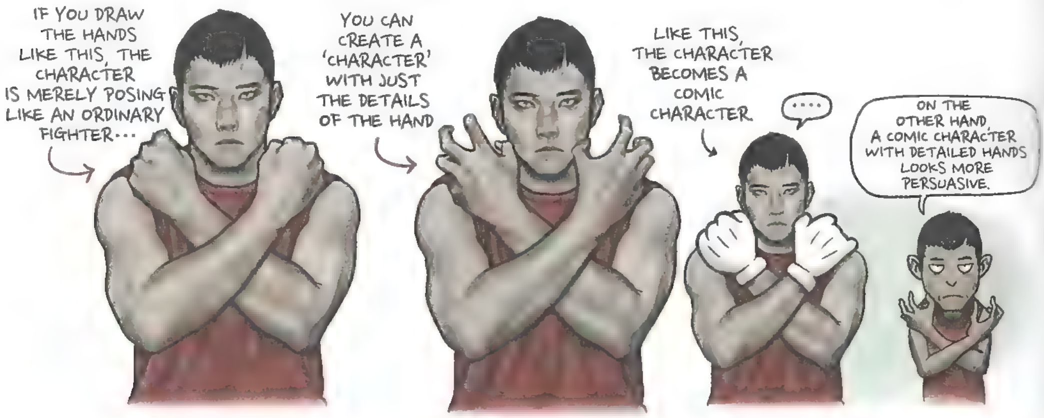


I'm a bit embarrassed about all the whining, but the hand is very important. For example, a characters' hand in a picture shows the nature, characteristics and emotional state of the character. That is why we have to know the structure and the general features of the hand. I have no idea why our hands look so complex despite their size. It gives me a headache just to look at an anatomical chart.

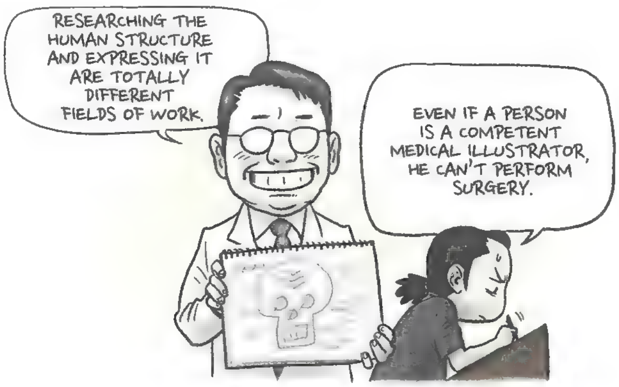
Because our hands are incredibly complex, most people give up early, and often many just draw the hand's appearance based on their memory. When illustrators draw hands, the 'hands' are like supporting roles rather than the main character. In other words, just drawing a rough figure of the hand is more than enough to tell the story, so why do we have to dig into the troublesome structure such as the bones and muscles of hands?



Maybe it's asking too much for an illustrator who's got a lot of other things to draw to dig into the structure of hands that doesn't even show that well. Even if this is the case, when I give a lecture on figure or character drawing, I tend to put more emphasis on describing the 'hand' rather than the face and I give more assignments on hands. No matter how much we talk about the cranial bones and jawbones of a face, the face drawing will most likely get modified based on the illustrator's taste. And that is acceptable but this does not work with 'hands.' If a face determines the 'look' of a character, a hand infuses 'life.' Frankly speaking, it is okay for a cartoonist to illustrate a character with an ugly face but it will be disadvantageous for the cartoonist if he can't draw a hand properly, because his range of expression diminishes greatly.

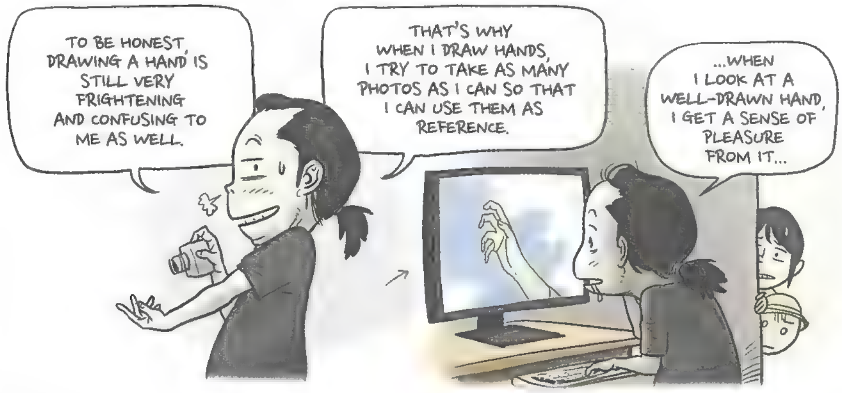


However, even if you've memorized all of the hand's anatomy, that knowledge will not necessarily help you draw a hand better. It's like not all anatomists that know the entire structure of a hand are good hand illustrators.



After all is said and done, the most important thing is the 'interest' in a subject. When you put more attention and interest in a subject, you observe that subject in diverse directions, which also increases your expression ability. To sum up, if you develop an interest and understand that subject structurally, expressing that subject becomes more fun. When you enjoy something, you tend to repeat the process over and over again.

Pardon my long introduction, but the hands are an extremely complex and difficult part of human body. I bet most illustrators would agree with me.

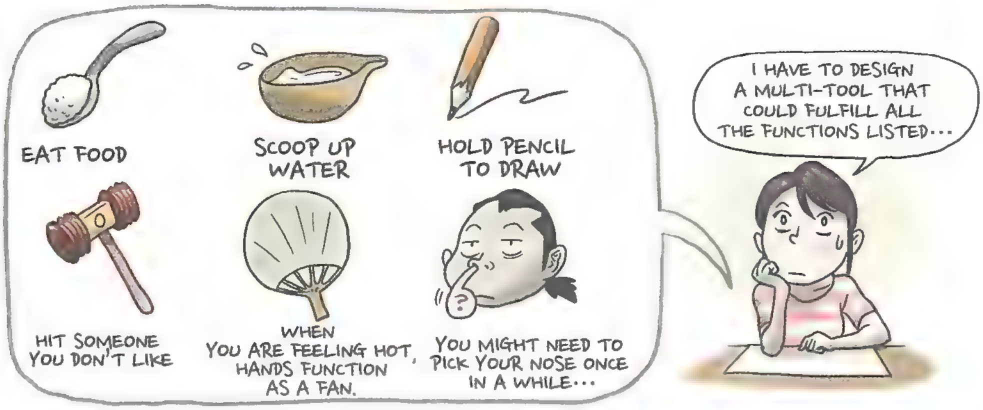


Anyways, hands are an important part of the human anatomy that illustrators should study at some point. Thanks to this chapter, I will also be able to study more about the hands, so let's dig in.

■ Let's Make Hands

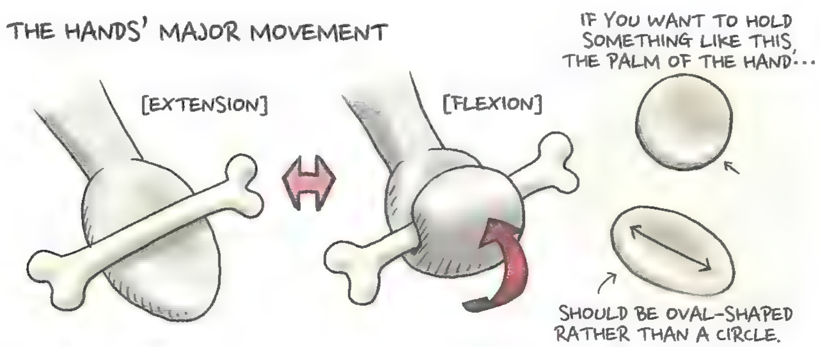
How would you define 'hands' in one word?

I'm pretty sure there are multiple ways to define our hands but, in my opinion, the most appropriate keyword for describing the 'hand' is 'tool.' It is not just an ordinary tool but is indeed a 'multi-tool.' From now on, we are going to learn about the structure of this tool but the problem is that there is no 'blueprint.' If this is the case, instead of 'analyzing' an existing tool, it is a better idea if we imagine as if we are 'creating' the tool ourselves. Let's all become designers that design this tool called the 'hand.'
Before designing the multi-tool, I think it is a good idea for us to list various functions that our hands perform.

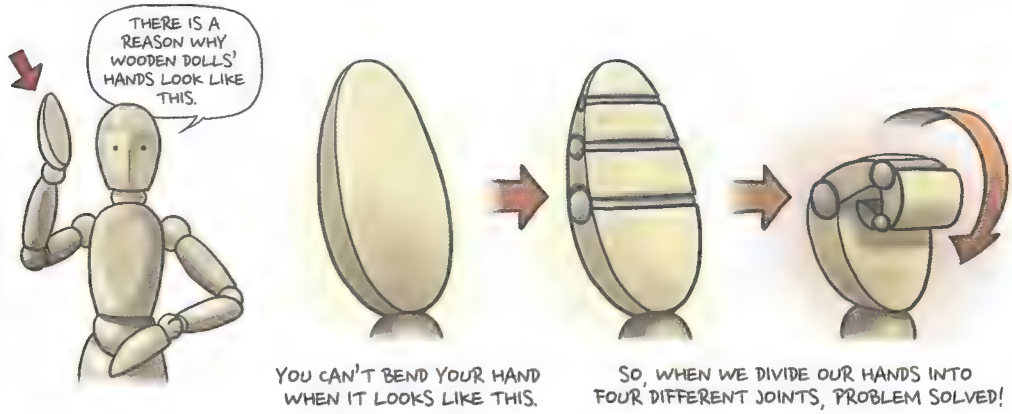


It's easier said than done, but designing this multi-tool for multiple roles is really difficult. To be honest, I think it might be impossible. Things that a 'hand' can perform listed above are just the tip of the iceberg. There are countless things that our multi-tool hands can do.

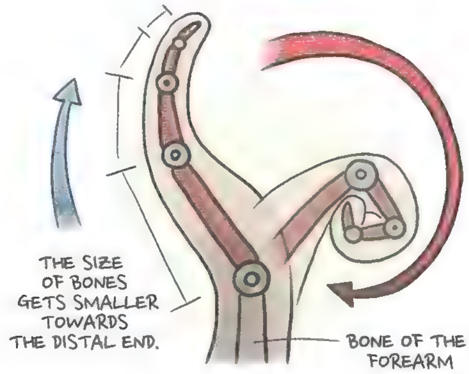
Great. Let's try to think this way. Among the numerous functions that our hands can perform what do you think is the major function? If our hands could only perform one thing, what do you think is the most needed movement of all? As mentioned earlier, thinking simply might be the key to a complex question.



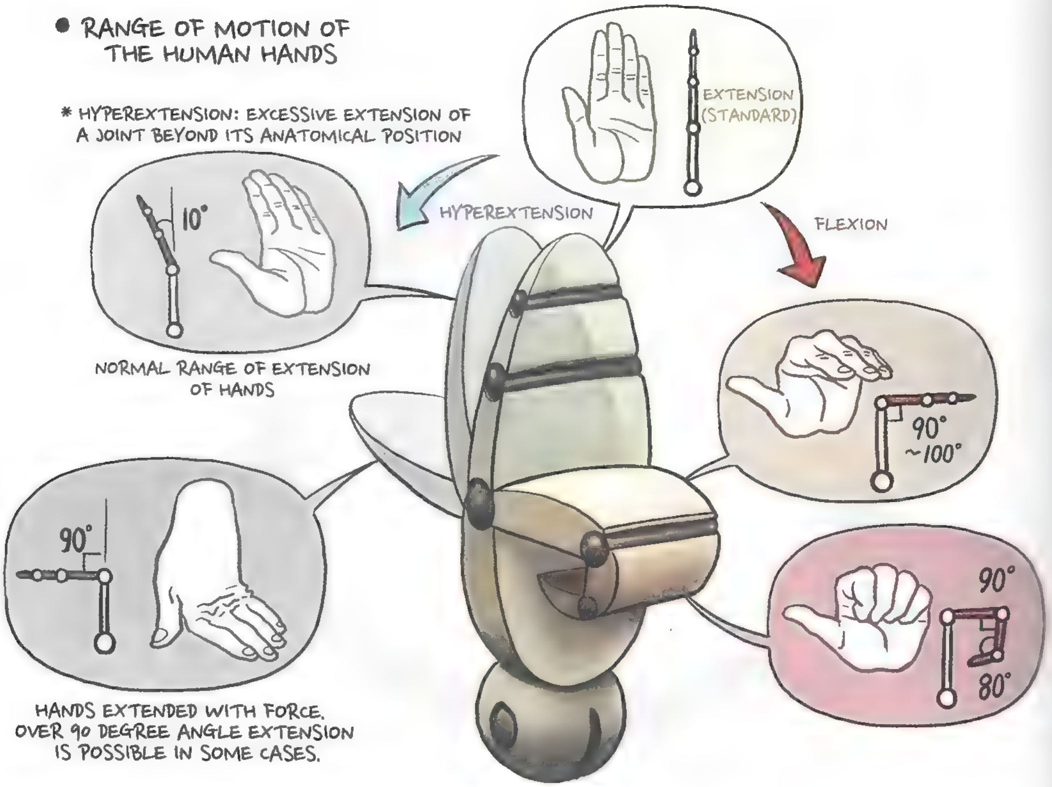
Even though our hands perform multiple roles, the foremost function is to hold or grasp things, which require the flexion and extension movements. In order to capture these movements, we should simplify the appearance of hands. We can do this by drawing an oval shape just like the picture above. The palm of our hands should be broad and long in order to hold things such as branches and stones more firmly. But, unlike mollusks like squid or octopus tentacles, human hands are made up of solid bones. Therefore, in order to bend our hands freely, our hands are also made up of multiple joints.



There's one thing to watch out for though. It would be most efficient to divide our hands into three parts in order to allow rolling movements to hold onto something. What's important is that the bending points do not have to be divided proportionately but, like the picture above, the bending points should get smaller towards the fingers. For each bending part, the appropriate ratio of the lower to upper bone is 1 to 0.8.

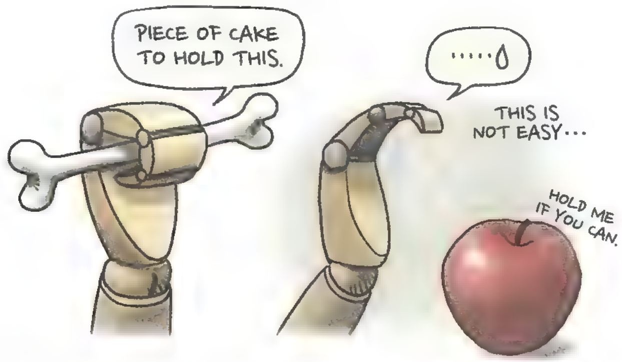


One more thing to consider is that the joints pertinent to the fingers should bend in only one direction rather than on both sides. As I mentioned earlier in the 'joints of arm' section (refer to page 303), because bending requires more strength than extending, being able to bend only on one side focuses the strength to one side.
There is an exception. In order to push oneself up from the ground, our fingers (metacarpophalangeal joint – refer to next page) can bend backward as well. Refer to the picture on following page for more information.

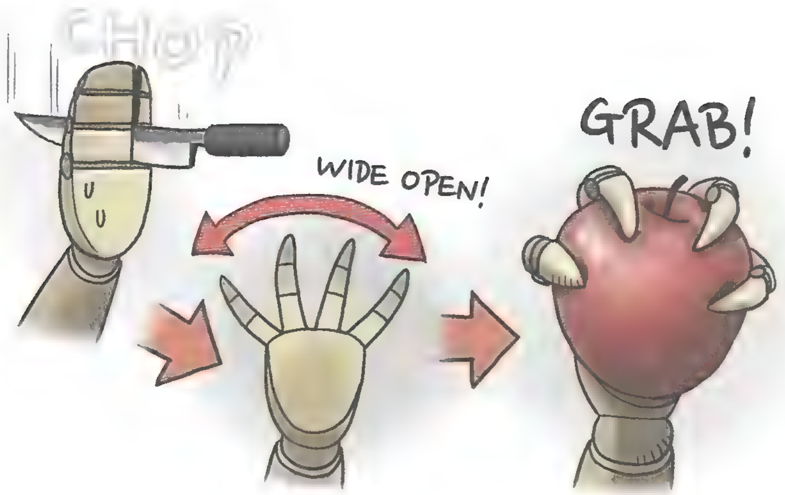


Please take a close look at the above picture because this picture will appear once again later on.

After producing multiple joints to a flat looking oval, it became more like the hand we know. But this isn't enough. Why? Because our hands need to hold and grasp other things, not just long objects like branches and bones.



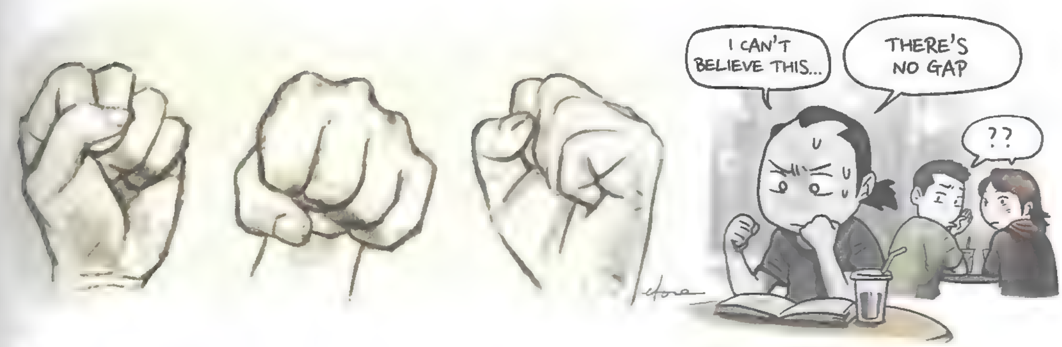
Our hands need a structural improvement to hold various shaped objects comfortably. There are many ways to improve our hands but as you all know, it is always good to keep it simple. Without further hesitation, why don't we divide the joints vertically into multiple branches to lock the objects from falling?



Hmm... honestly, it's difficult to say that our hands can fully hold an apple steadily at this point, but it's a huge improvement compared to before, right? We call these vertically divided parts 'fingers.' As you may all know by now, our fingers are divided like this in order to hold objects more firmly. But, there's a fundamental reason why we have fingers.

Until Our Hands Become Feet

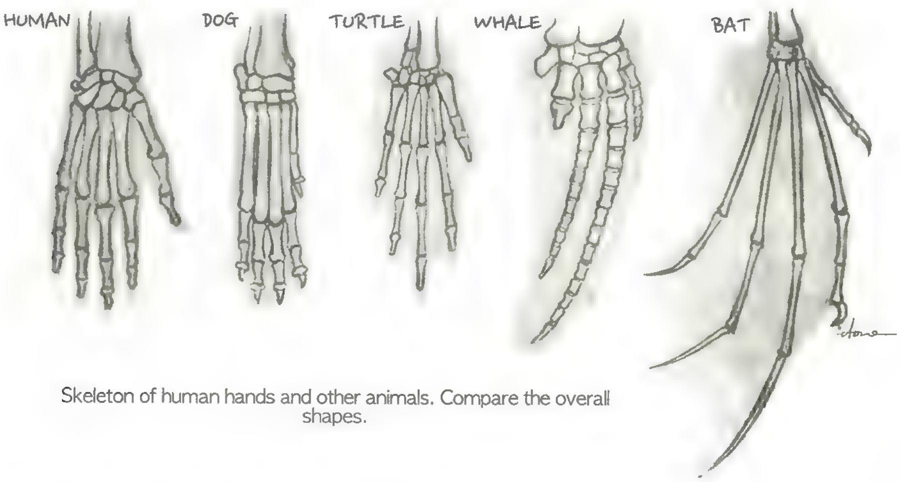
Lower the book briefly and try clenching your fist and observe it as you rotate it. When you clench your fist, you will realize that there's no gap and that everything fits perfectly. Although you may clench your fist every day, it may look new and fascinating to observe your fist like this.



This time, grab a pencil or an eraser on your desk like you'll never let it go, then once again observe while rotating your hand. As you can see, the reason why we can hold onto different shaped-objects is because the shape of our fist changes depending on the shape of the object that we hold.

Our fist changes flexibly depending on the shape of object we hold

This is clear evidence that the human hands have numerous joint structures. But, if our hands consist of multiple joints to grab something, what about four-legged animals that use their fore-limbs merely as a means of transportation? Do they have simpler structures than that of human hands because the fore-limbs are only needed for walking?
Let's look at the following picture.



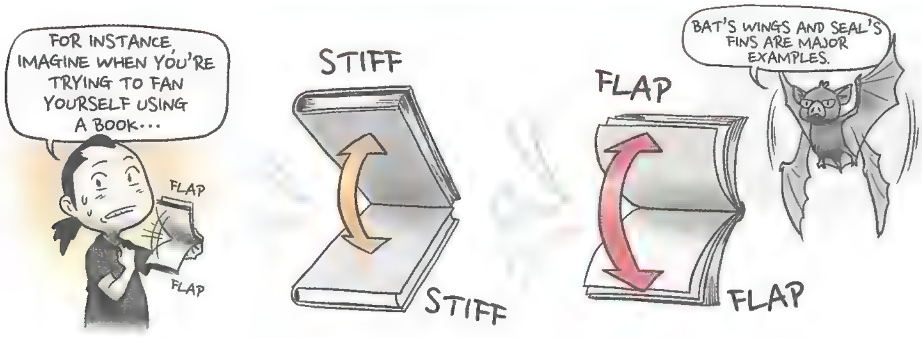
Skeleton of human hands and other animals. Compare the overall shapes.

You will have realized by observing the picture that despite human hands and the fore-limbs of other animals having slight differences in size and number of bones, the similarity is apparent. The similarity remains even though four-legged animals do not use their fore-limbs to hold or grab objects like humans.

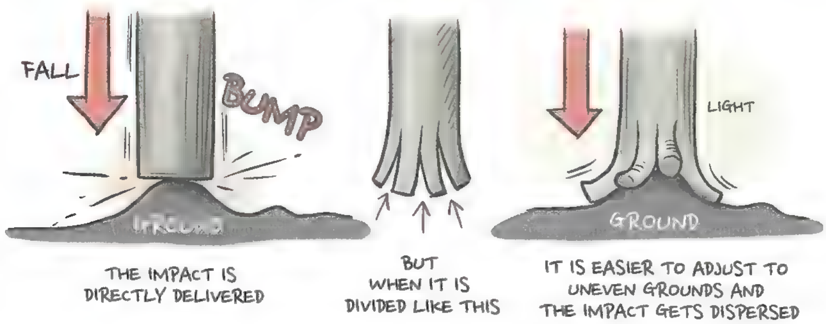
What do you think this implies? As I mentioned before, human hands were actually feet before and were used as a means of transportation just like that of other four-legged animals.

Realizing that this is a very important clue to understanding the structure of the hands. Even if the fore-limbs are used as 'webbed feet' or 'wings' rather than 'feet,' they are still commonly used as a 'means of transportation.' If this is the case, it is more advantageous if the forelimb or the hand has more bones compared to other parts. There are two main reasons why.

❶ (Commonly) Movement is detailed and multilateral in order to cope with diverse situations

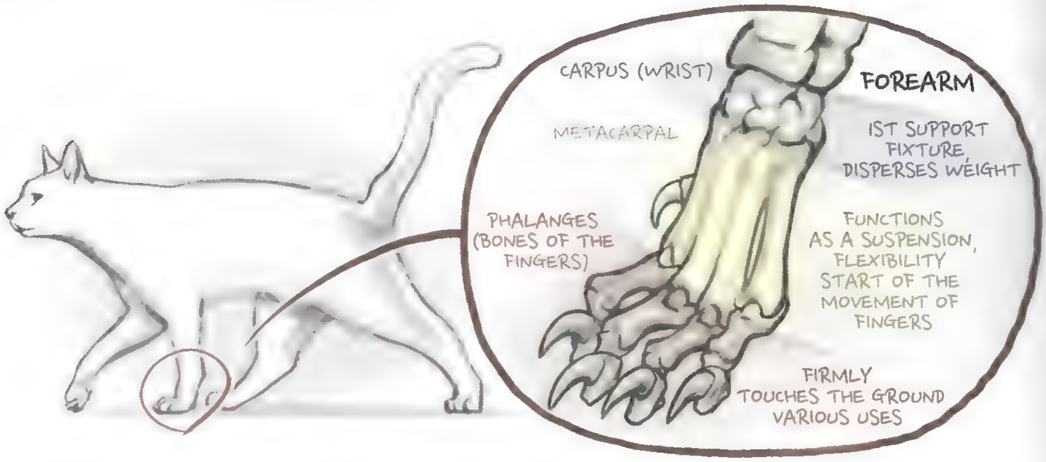


❷ (For land animals) To effectively cope with stepping on bumpy ground and to absorb the impact

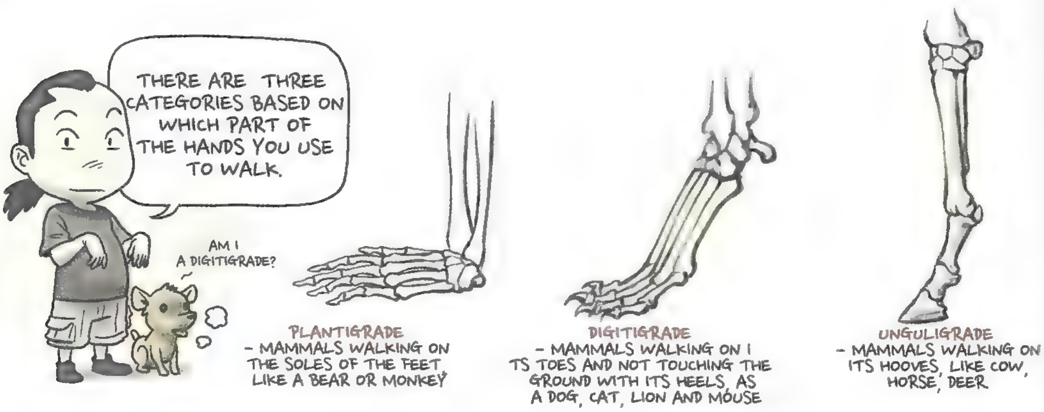


In sum, the hand—the distal part of the forearm—will be more advantageous in transportation if it is divided into multiple bones. For this reason, the number of bones increases towards the bottom of the arms, and the function gets more specific and complex.

Especially in the case of land animals (also early humans) that have to walk and run using the forelimbs, the forelimbs are divided into three main parts in order to disperse their weight whe stepping on the ground while flexibly pushing their body forward.

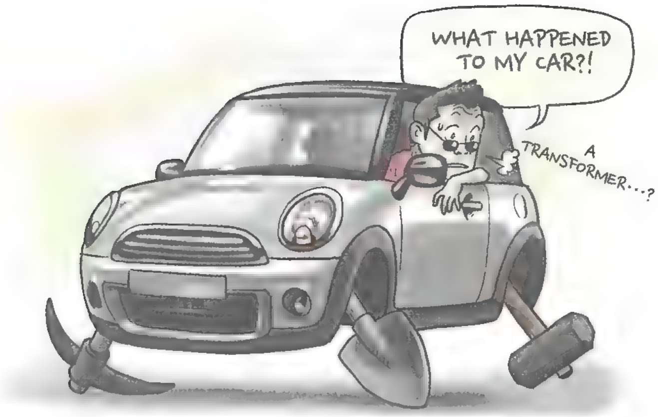


This applies to humans that used to walk on forelimbs. Not only humans but all mammals and land animals specifically developed the use of their forelimbs to suit their environment and needs.



Human forelimbs or hands can be both plantigrade and digitigrade. But strictly speaking, the front and back feet do not function exactly the same way when walking. Especially for plantigrades, frequently the hind leg walks in the plantigrade mode while the foreleg moves as a digitigrade. Simply use the above example of a foreleg as a reference / Detailed explanation can be found on page 531.

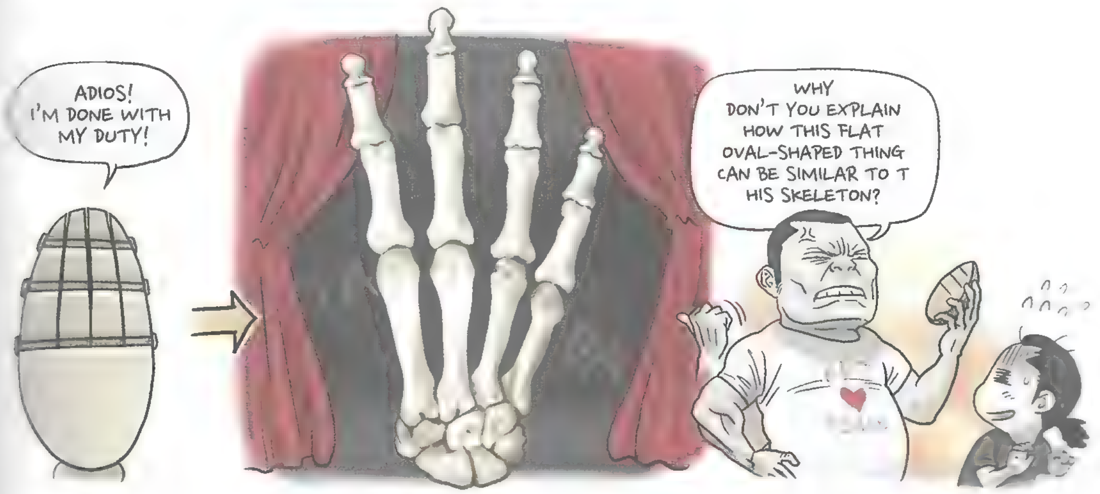
As I mentioned several times, as soon as humans started to 'stand,' human forelimbs started to undergo an enormous functional change. If I compare this drastic change to a car, it is as if the front tire suddenly evolved into a shovel out of the blue.



Although its function changed drastically, the structure of the hand preserved its form from the time when it was used as a means of transportation/locomotion. I guess it's not the shape of tools that matters but how they are used.

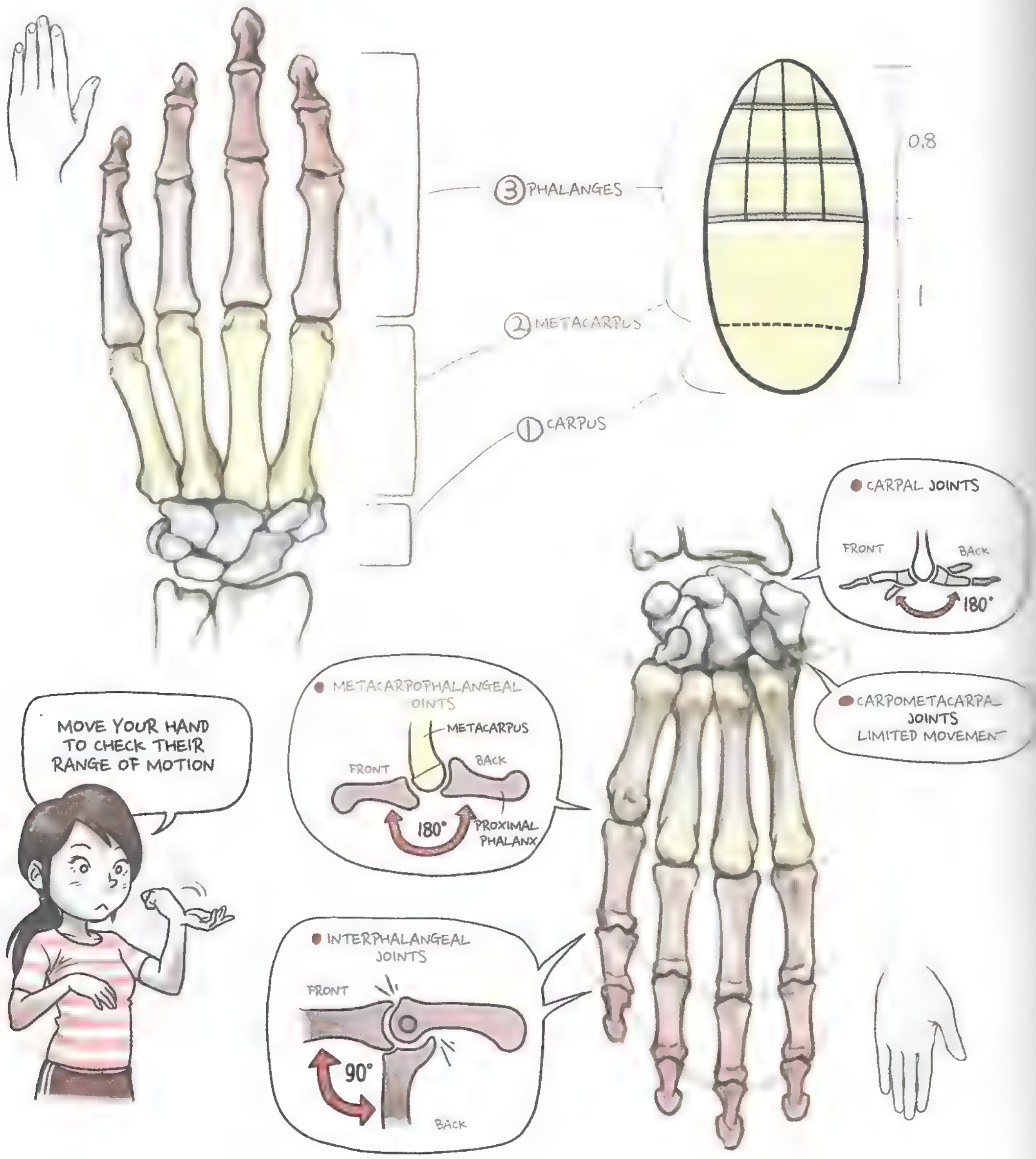
■The Carpus, Metacarpus and the Phalanges

So far, we explored why our fingers had to be divided. Now it's time to compare and contrast with the actual skeleton of the human hand. Briefly close your eyes and recall what we've covered so far and then we'll look at the actual skeleton of the human hand. …



I knew it… just like what happened during the pelvis section, even though we went over the basic principles, I can't help but panic when I encounter the actual figure of the bone. This is expected because our hands consist of so many joints.

On the other hand, that's why it is much simpler if you group the bones based on the distinctions of the 'joints.' Please study the below picture closely first.

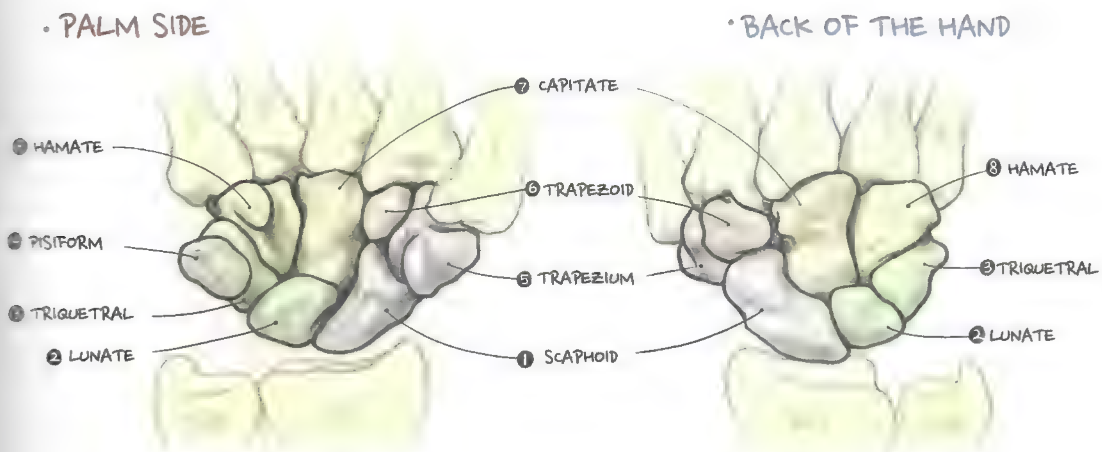


It still looks complex but the main point is simple.
Except for the thumb, just remember that the skeleton of the hand can be divided into three sections: the carpus, metacarpus and the phalanges. If you are still confused, please refer to the picture presented earlier in page 384. Next is a description of the three sections that make up the hand—carpus, metacarpus, and the phalanges.

Carpal bones

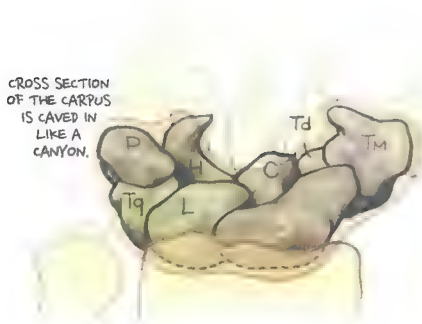
The Carpal Bones are the 'starting point of the hand' where it distinguishes from the forearm. The 'carpal joint' where the radius and carpal bones are connected produces 90 degrees of flexion front and back on top of eversion and inversion. However, it doesn't produce any rotation (refer to page 319).

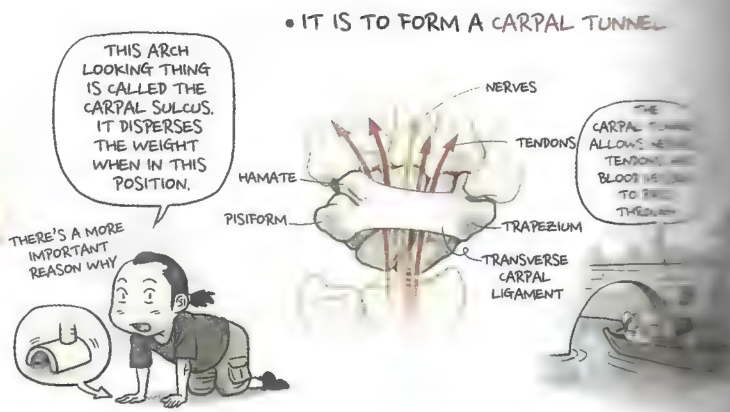
The Carpal bones consist of eight small bones and they function to disperse the weight when all the impact is concentrated on the wrist when hands land on the ground. It is firmly linked together by ligaments so there's almost no movement. Please refer to the following picture for individual names.



1. Scaphoid: S (Short for scaphoid)
2. Lunate: L
3. Triquetral: Tq
4. Pisiform: P
5. Trapezium: Tm
6. Trapezoid: Td
7. Capitate: C
8. Hamate: H

When carpal bones are observed from the front in a flat shape like this, they look like pebbles gathered together along the river, so it is difficult to figure out the features. But if we observe the carpal bone from below, we can see that the protruding 'pisiform' and 'hamate' form a U-shaped grouping rather than a flat face.

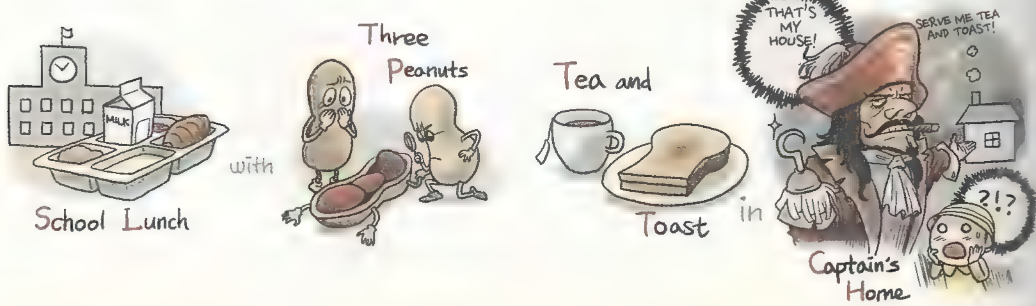




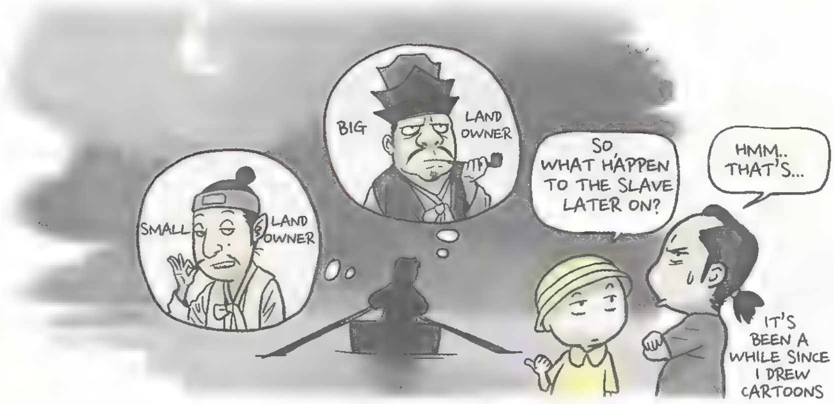
Wait! Let's Memorize the carpal Bones

The individual names of carpal bones are based on their unique appearance. (For instance, the scaphoid looks like a 'scaph (boat),' and the 'lunate' situated in the front and back of the carpus is called the 'lunate' because it is a 'lunar shape.') Regardless, it is still very difficult to memorize all the terms. Of course, it is not necessary to memorize every single name if the purpose of studying the hands is to draw. Anyways, just in case there are students trying to specialize in medical fields, let me show you a small tip using the initials of the names of carpal bones.

School Lunch with Three Peanuts, Tea and Toast in Captain's Home



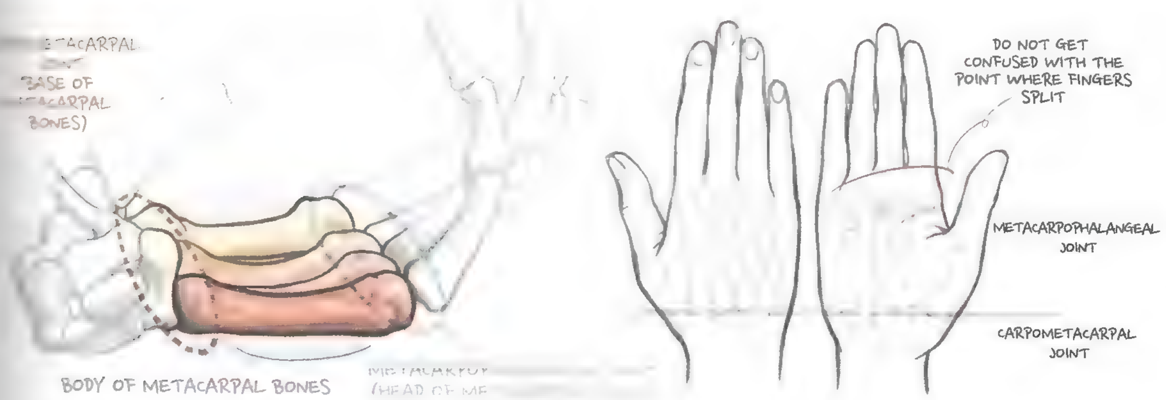
On the ferryboat gazing at the moon, my triangular-shaped bean was taken by big landowner and small landowner, and I grazed their head with a hook.



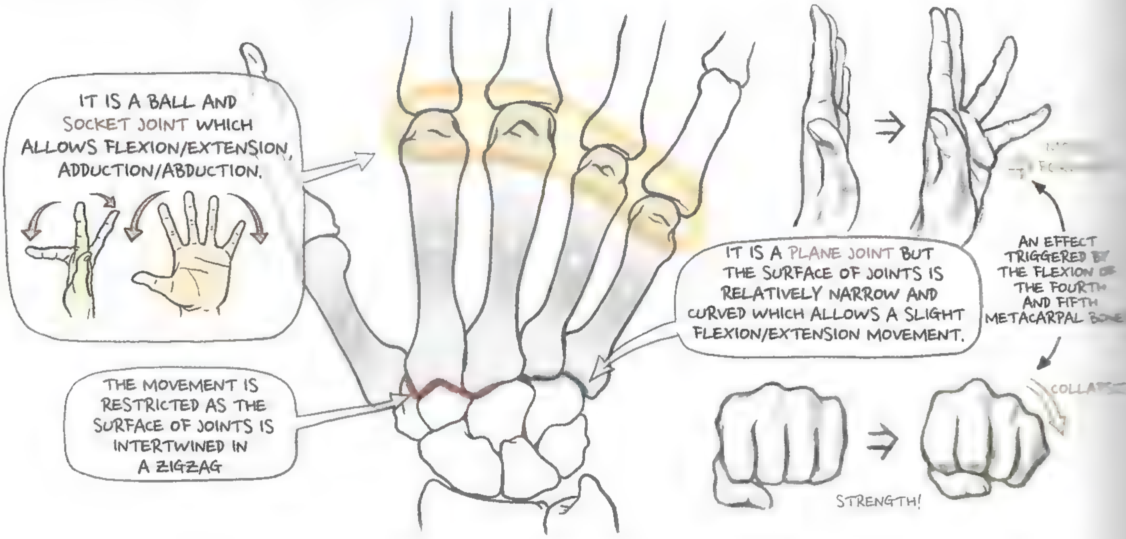
This may seem like some kind of poem, but this was my last-minute effort to memorize the order right before the school project. The story is somewhat forced and bizarre, but it was on effective mnemonic because I can play out the story in my head. The method may be tacky, but it may be the best way to memorizing things.

❷ Metacarpals

The metacarpals support movements of the fingers and they are the largest bones that make up the hand. Metacarpal bones are slightly bent toward the back of the hand in order to disperse the weight. The second metacarpal bone (metacarpal bone of the index) is the longest and the first metacarpal bone (metacarpal bone of the 'thumb') is the shortest.
In human anatomy, the metacarpal bones are the intermediate part of the skeletal hand connecting the carpal bones and phalanges.
One thing to note is that the upper and lower parts of metacarpals have different joints.

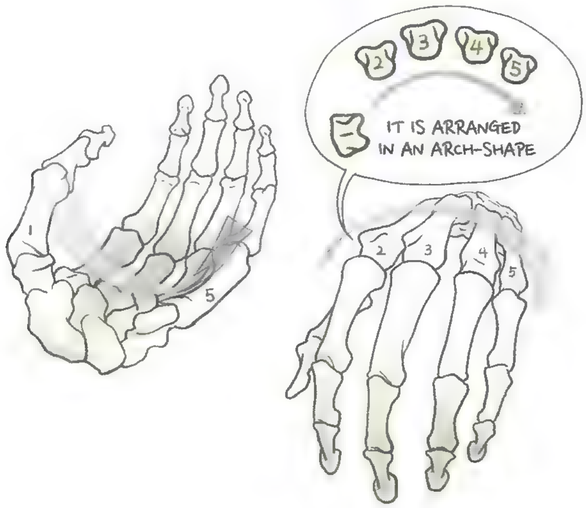


The synovial joints that serve as the articulation between the carpals and metacarpals are called the carpometacarpal joints and the condyloid joints. They articulate between the phalanges and metacarpal bones, which are called the metacarpophalangeal joints. It is very important to distinguish these two joints as the nature of the movement and range are different. To summarize, just remember that compared to carpometacarpal joints that are connected to the wrist, the movement of metacarpophalangeal joints is more flexible as it is the starting point of fingers that have more movement.



[BACK OF THE HAND]

Like the carpus, it is easier to observe the external appearance of the metacarpus when you see it from an oblique angle rather than from the front and back plane. The metacarpus is connected to the carpal bones that form the 'carpal tunnel' (page 392) and thus the metacarpus is also arranged in a low arch shape. This shape influences the phalanges (page 398) as well, so ultimately when human hands are relaxed, they take the shape of a dome.



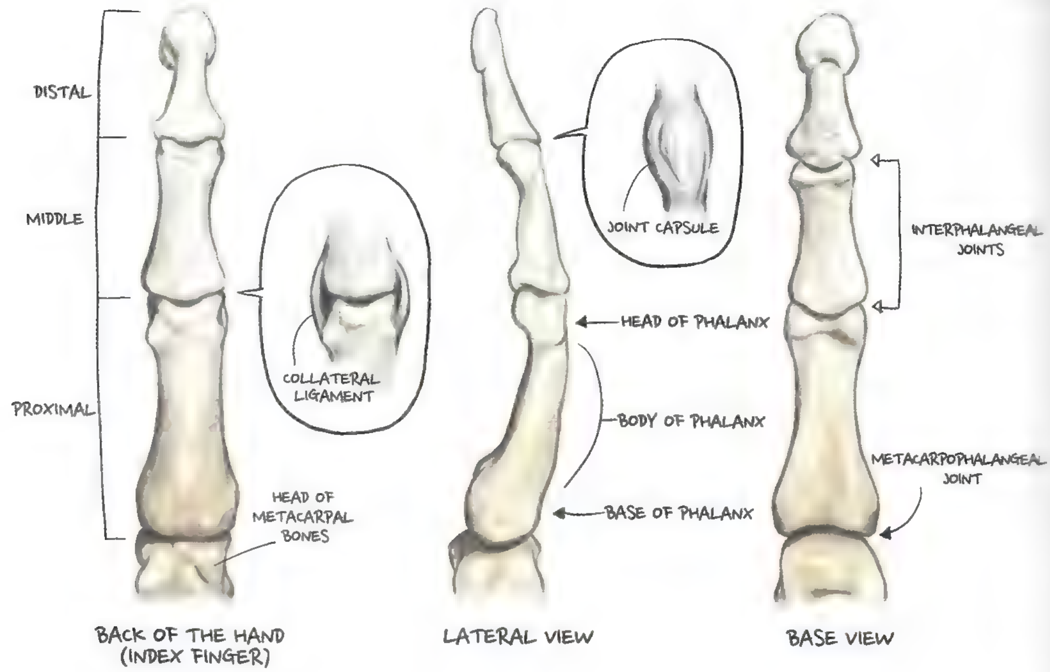
Phalanges

It is important to summarize and go over the names and orders of the fingers before delving into the appearance of our fingers. The digits of the fingers are numbered from 1 to 5 (first to fifth) beginning with the thumb. We call individual phalanges the first to the fifth finger, but they also have different names. Please refer to the chart below.

Common names of fingers
Thumb
Index, second finger
Middle, third finger
Ring finger, fourth finger
Little, fifth finger

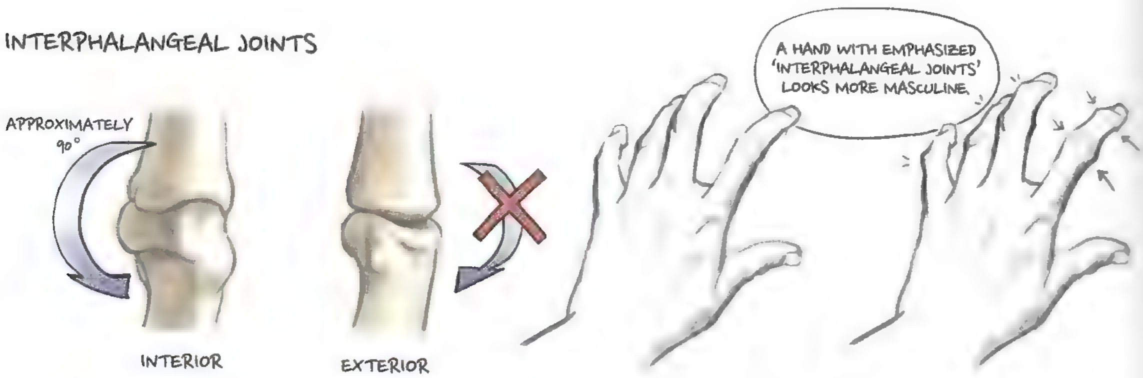
Since this book is an anatomical book, it would be more appropriate to use the official anatomical names such as 'first finger, 'second finger.' But because the anatomical names are long and we tend to use more familiar names such as 'thumbs' and 'little fingers,' it is common to mix the names in anatomical fields. (Example: flexor pollicis muscle. abductor digiti minimi muscle).

Anyways, let's delve into the explanation of fingers. Except for the thumb. each finger is divided into three phalanges—the distal (the bone on the tip of the finger). middle and proximal (the bone at the base of the finger) phalanx. Please be mindful that the phalanx, as it becomes distal to the body, gets smaller at an approximate ratio of 1 to 0.8.

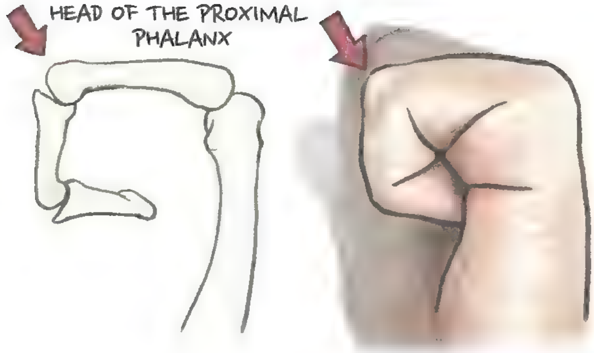


The proximal end of each phalanx is the 'base' and the distal end is the 'head.' The interphalangeal joints connect the phalanges on the head and the base sides. They are 'hinge joints' which allow the bones to only flex inward.

INTERPHALANGEAL JOINTS



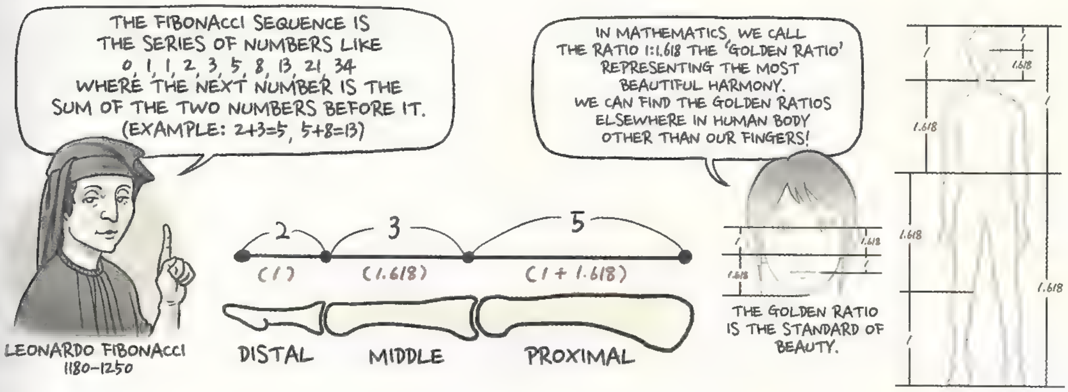
As you can see from the pictures, having a thick phalanx means that the ligaments connecting the phalanx are well developed and that ultimately the grip is strong. Characteristics such as the 'head' of phalanx protruding in a clenched fist or a well-developed phalanx are features of a 'masculine hand.'



It might sound obvious but please note that the length of each finger is different. The middle finger is typically the longest and the little finger is the shortest among the five fingers.

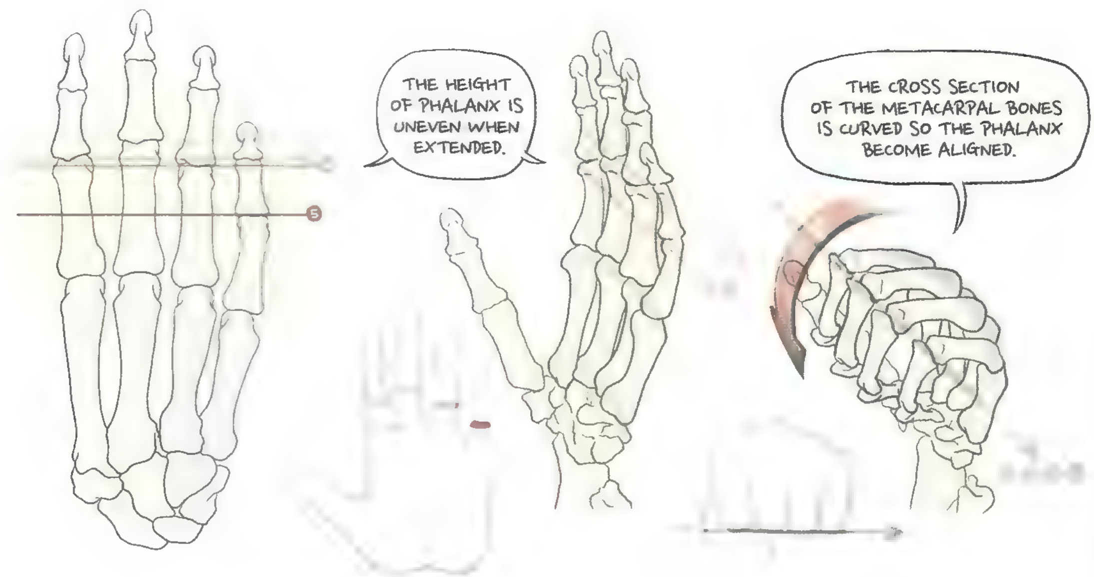
Wait! The Golden Ratio Hidden in Fingers

I just told you that the length of each finger is different, but there's a fun fact connected to this. Even though the length of each finger is different, the ratio of each phalanx is almost the same for all five fingers. The ratio is approximately 1 (proximal): 1.6 (distal). This is close to the 'golden ratio' in the 'Fibonacci Sequence.'



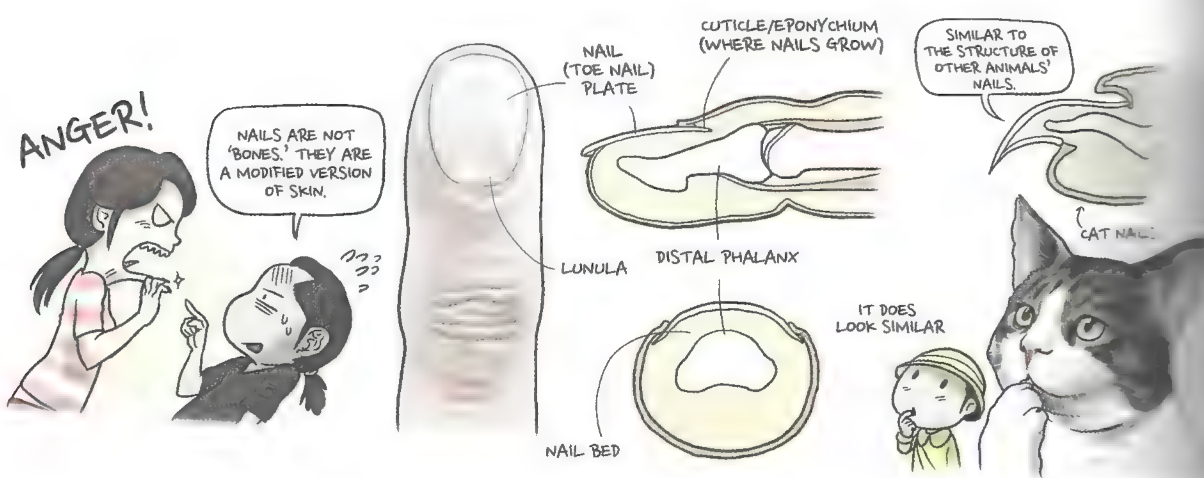
Similar ratios to the 'golden ratio' not only on the human body but also in nature such as flowers and insects. You can also find it in daily life objects such as credit cards, commodity stands and A4 papers (Not an accurate measure). The reason why this ratio looks beautiful is because it is the most efficient in terms of movement and space utilization. We are able to bend our fingers in a whirlpool shape thanks to this golden ratio. Lately, there have been controversies about the myth of the 'golden ratio.' But the ratio being found on the human body is a fascinating coincidence and a mystery.

Because the length of each finger is different, the interphalangeal joint of each finger is at a different height. However, this changes in clenched fist.



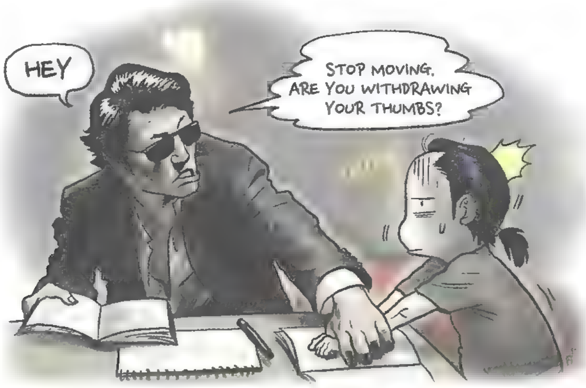
When you clench your fist, the proximal and middle joints are not the only joints that align. The middle and the distal phalanx also align. In conclusion, the location of phalanges (interphalangeal joints) is all different so that there's no gap when we clench our fist. A picture is worth a thousand words so, why don't you see how you clench and unclench your fist?

Lastly, we should not leave out 'nails' when talking about fingers. Frankly speaking, nails don't need to be discussed here because they are not 'bones.'



Nails are relatively firm and thus often mistaken as bones. But they are actually a part of skin —the hardened part of the outermost layer of the skin, to be exact. We know this because it's made up of keratin, which is a key component of hair and skin. That's why it keeps growing even after it breaks.

So we've learned about the different bones in the hand, but we can't help but feel like we've left something out. Hmmm…



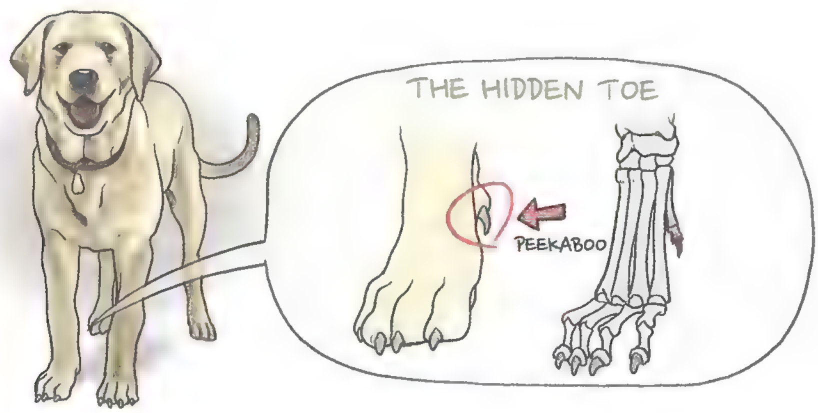
That's because we've left out the explanation about the thumb or the first digit of the hand. We didn't forget about the thumb, we just left it out on purpose. Why? Because, the thumb is so special that it even has its own name.

■Fingers Face the World

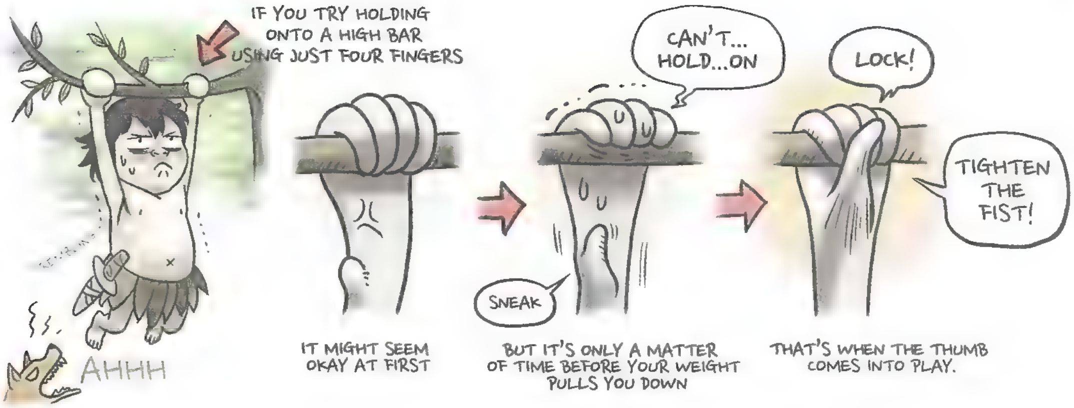
When I was young, I was a typical kid who enjoyed watching cartoons that feature personified animal characters. But I had one burning question every time I watched these cartoons. Some of you may have asked this question at some point …

I was dying to know! I learned it's because most four-legged animals only have four toes and lack the big toe. And it was way later that I found out they actually do have big toes or thumbs.

The big toes of four-legged animals, called dewclaws, are often hidden or vestigial, which explains why cartoon drawings don't bother drawing them. They only play a minor role in structurally supporting the second toe, which absorbs a lot of the force when the front foot hits the ground. So even though animals can use their front feet like a rake to scrape or pull in something, they can't use them independently to grab something or make a fist.



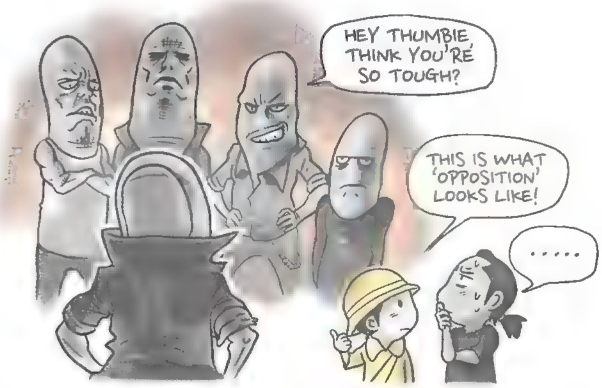
You see, making a fist isn't just about retracting a flat hand into a round shape. It's about the grip, or the power created as the bended fingers tighten as one. That's why four fingers aren't enough to make a fist – you need something to lock the fingers from the outside. And that something is the thumb!



When you think about it, making a fist is a sophisticated act. Humans have nothing to protect themselves with but their fists, and the thumb is what enables a strong fist.

One of the most recognized characters in Korean comics, Hye-Seong Oh and Eum-Jih Choi (© Lee Hyun Sae Production)

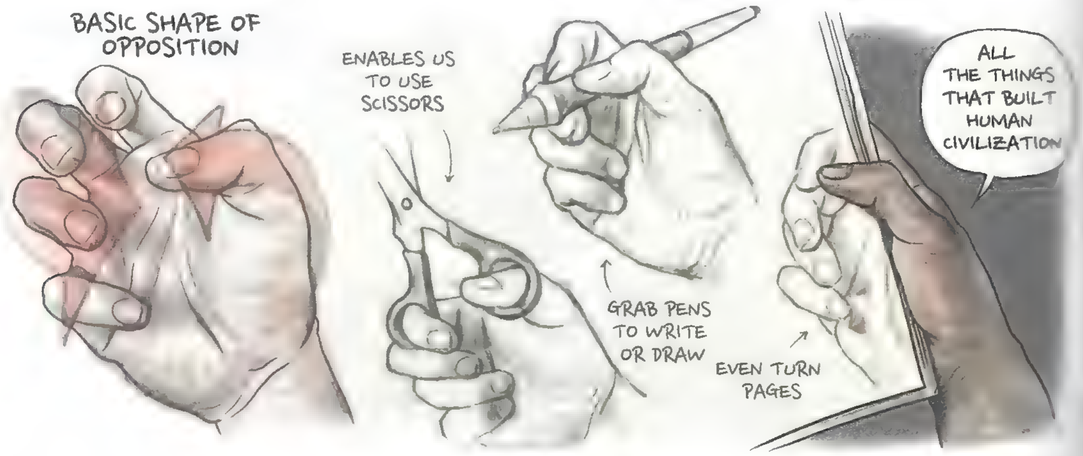
In order to make a fist, the thumb must face the other four fingers in an action known as opposition.



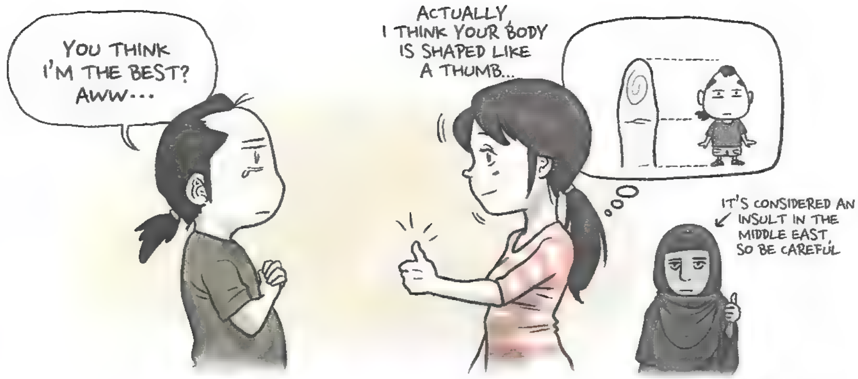
Opposition literally means the thumb opposes the other fingers. During this action, the hand makes the shape of alphabet C, which is considered to be the most important and dramatic shape that the hand can form.

The C shape made by the hand during opposition is the most basic form of the hand from a functional point of view. The C shape in opposition is the most basic form of the hand that is applied to toy hands that need to be able to grab something with a fixed position.

Opposition may not look like much more than just a slight bending of the palm and may even look slightly awkward, but it's an action unique to humans. Opposition is possible to some extent for other primates like chimpanzees and orangutans, but they cannot use like humans. Opposition is crucial not only to grab objects but to do all the precise, crafty things with one's hands, such as writing and making tools. So it's no exaggeration to say that opposition is what sets us apart from 'front feet' and 'hands.'



In other words, opposition is the driving force that made humans the strongest species on earth and the thumb plays a key role in opposition. So, it's no surprise that we give thumbs up to mean 'the best'!



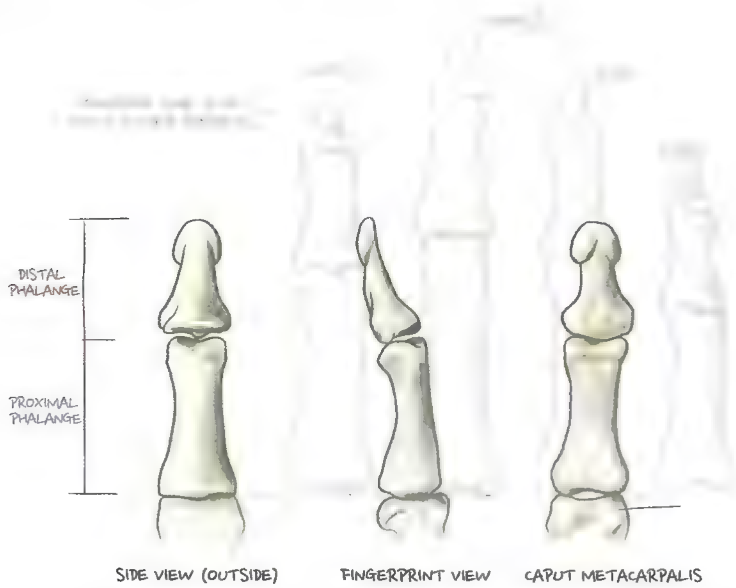
In behavioral psychology, thumb pointing upwards signifies a healthy state of body and mind and is called "gravity defying action."

Thumbs may have played a minor role in four legged animals but it became the secret weapon that helped achieve civilization of humanity. So much must have happened in between...

That's enough idle talk, let's learn about the thumb and its appearance.

■Thumb or Pollex or the First Digit of the Hand

First, this is what the skeleton of the thumb looks like.



At a glance, the thumb doesn't look much different than the other fingers we looked at. The only noticeable trait is perhaps that it's the shortest finger?

But considering that the thumb plays a 'very' important role in helping the hand fulfill its purpose as a tool, the thumb has many extraordinary traits compared to other fingers. Here are some examples:

❶ Number of phalanges

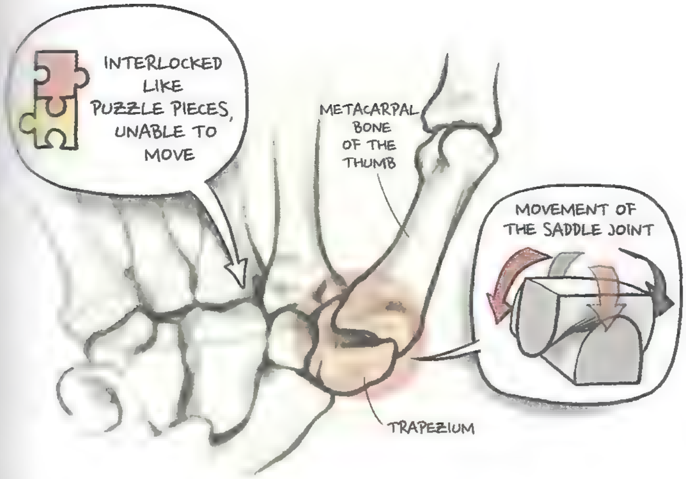
Open your hand and count the number of phalanges or the bones of your fingers. You can see easily that the thumb only has two phalanges whereas the other four digits have three phalanges. Why is that?

After a closer look at the bones, you may think the metacarpal bone of the thumb is maybe in actuality the proximal phalange. In fact, there are some theories that consider the metacarpal bone of the thumb to be the proximal phalange. But the widely accepted theory from an embryological point of view is to see the distal phalange (3) as having merged with the medial phalange.

As you can see in the diagram, the thumb has less joints and a shorter overall length . But that's probably what makes it stronger than other digits. As we explained earlier, the thumb needs to be strong since it plays a crucial role in making a strong fist.

❷ Carpometacarpal joint

The thumb also stands out from other fingers in the carpometacarpal joint, where the carpal bone and metacarpal bone meet.



Movement is restricted for other fingers because their carpometacarpal joints are plane joints. But the carpometacarpal joint of the thumb, the trapezium and the articular surface of the proximal phalanx are saddle joints, thus making movement relatively easy for the thumb. That's why we are able to use smart phones so well, all thanks to the saddle joints that help our thumbs move easily.

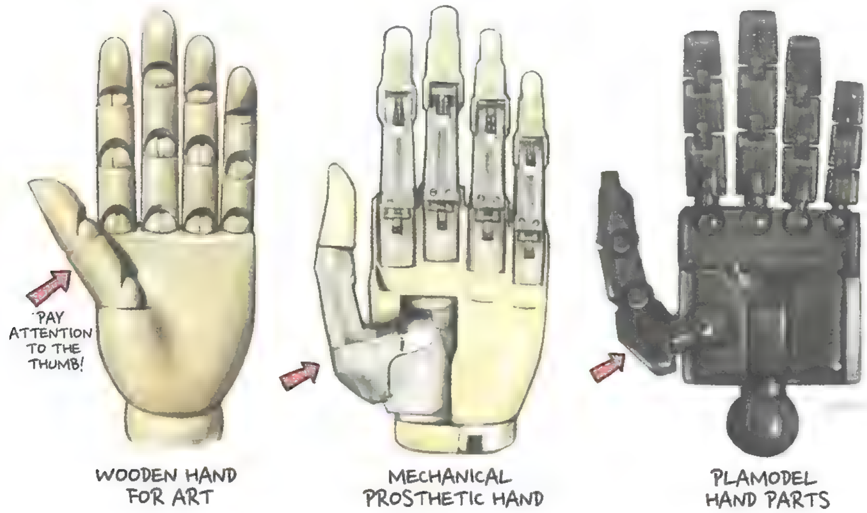
❸ The Starting Point and Angle of View

Once again, put the book down and bend your hands slightly. Which way are the fingers pointing when the fingertips are facing you?

All the fingers are aligned, looking at the same direction, except for the thumb. It almost looks like the thumb is an instructor looking at his students from the side. Refer to the below diagram

This is because the trapezium, the starting point of the thumb, slightly faces in toward the pal
to enable the opposition movement.
So, when the hand is relaxed, it is closer to a three-dimensional letter C rather than a flat surface
We will discuss this again later.

So, we could say that robot hands and prosthetic hands are the results of research into the thumb. Like so, it can be quite useful to observe other objects that take the shape of a hand to better understand the structure of the hand.

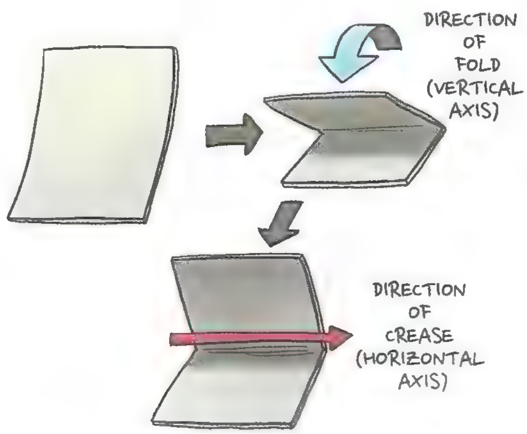


No one finger is more superior than the others, but the thumb does stand out from others when it comes to its role, usefulness, and importance.

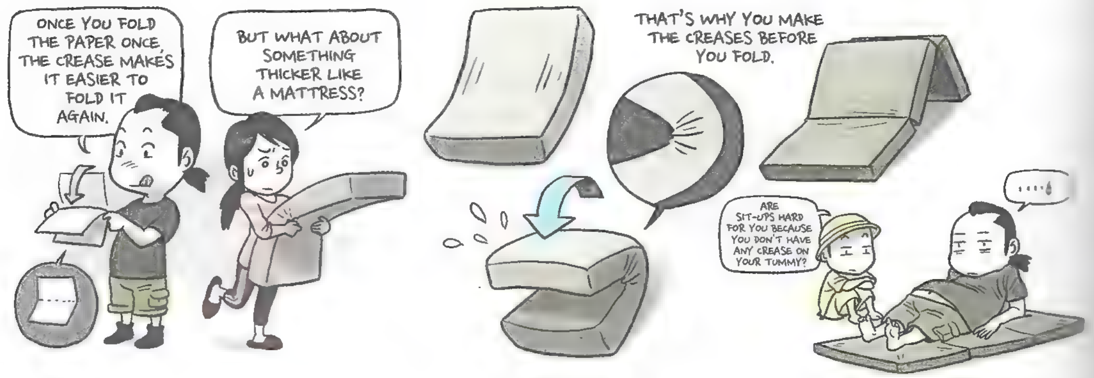
■Shall We Read the Palm?

We constantly look at the palm of our hands, even when we're not drawing it. You may have noticed something on the palm, the lines. We can't leave out the lines of the palm when we're discussing hands, so let's briefly go over this important feature.

Why do we get lines on our hands? Well in short, these are wrinkles.
The wrinkles are creases on the skin over our bones that make it easier to move our hands during flexion and extension. In other words, these lines tell us more or less how the hand moves.

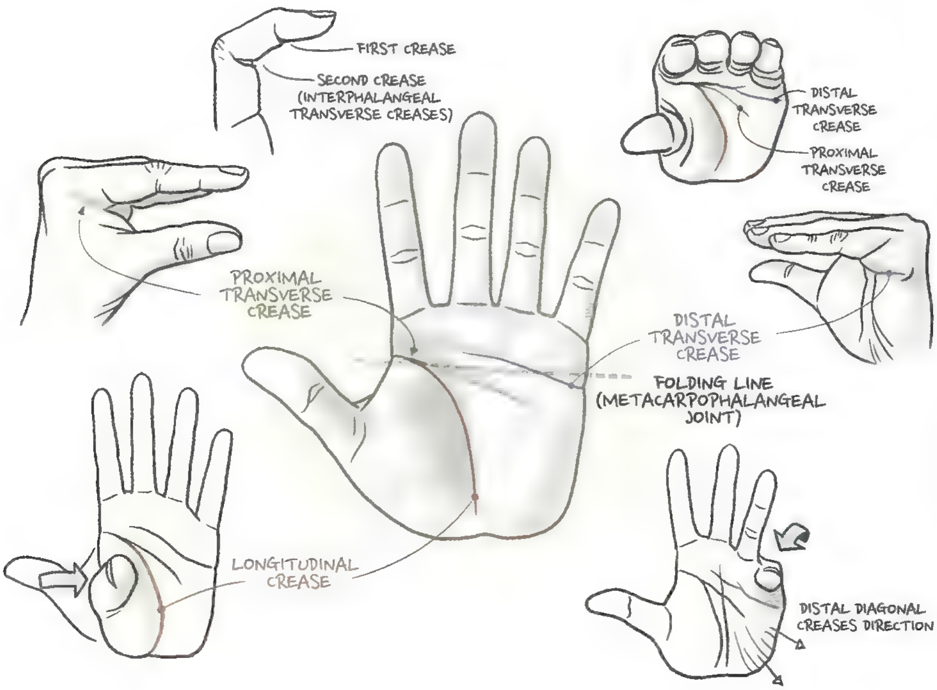


When you fold a sheet of paper in one direction, it creates a crease. This means looking at creases will give us information not only about the movement, but also the intensity and frequency of the movement based on the depth and size of the crease.



We often think of the palm as being soft and tender, but the surface of the palm is actually q tough and thick because it has to directly touch various objects. But no matter how freely the bones may move, it's hard to bend the hand if the skin covering the bone is too thick. That's w the lines form a crease, making it easy for the hand to bend over the crease.

The hand can move in a variety of directions, but since we're studying anatomy not chirogno we will only look at the three main lines that represent the biggest movements of the hand (flexion, thumb flexion, palm flexion). These three lines are essential when drawing the palm. s be sure to memorize their placement.



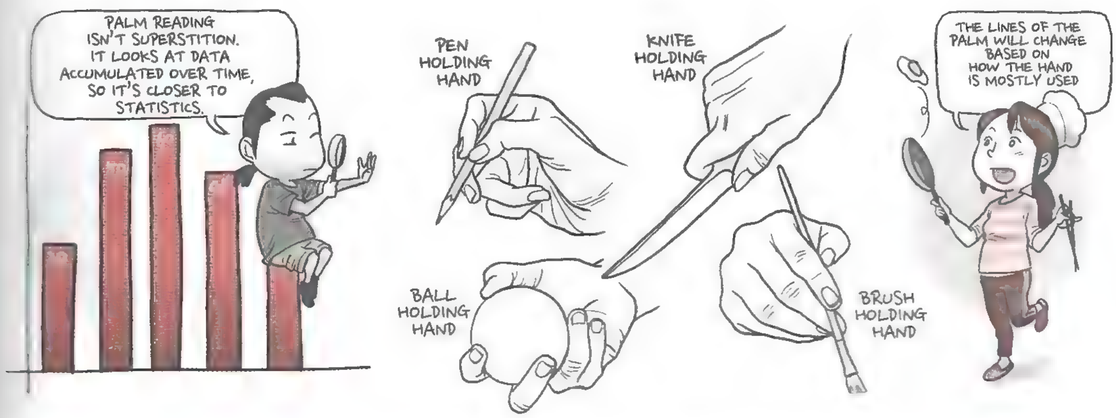
Wait! Surface Anatomy

Surface anatomy is the study of milestones such as creases and protrusions on the surface of the skin to gain insight on internal anatomical structures. It is especially useful to observe external features to better understand the internal structures of body parts that move a lot like the hand.

Refer to diagrams in the back of the book (page 600) for examples of surface anatomy of the entire body.

It might seem far-fetched that mere wrinkles on the hand can tell you the fate and future of a person, but it's a bit more understandable when you look at how these lines work.

Hands are made specifically to move, so they evolve to optimize for recurring movements, affecting palm lines in the process.
The fact that hands repeat certain movements implies that the movement is closely related to the very survival of the person. The study of the information that has accumulated over time in a person's palm lines is called chirognomy.



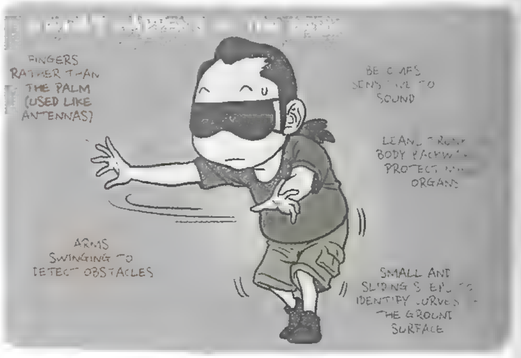
Hand and palm lines are inseparable, so I suggest you take a look at the lines on your palm when you get a chance. Hopefully, it will give you a better understanding of your life and your lifestyle patterns based on how you use your hands, and maybe even help you shape your future for the better.

Hands Talk, the Language of the Hand

One thing we need to remind ourselves is that the hand is above all a sensory organ, regardless of all the physical roles it plays. Do you know the story of the blind men and the elephant? The moral of the story is that we need to be careful when generalizing based on the limited information. However, imagine what would happen if we didn't have any information about the elephant at all. We would be put in much greater danger.

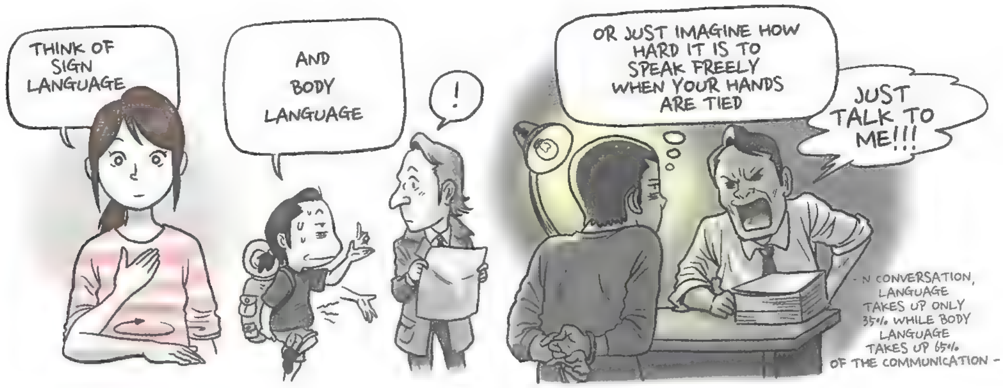
Recognizing objects through touch and observation is one of the fundamentals of science.
Without it, humans would not have survived.

As I have already mentioned, collecting and analyzing external information prior to acting is crucial for the survival of living things. In circumstances where eyesight is impaired, the hand plays an essential role and our brain has no choice but to rely on signs sent by the tactile senses of our hands.

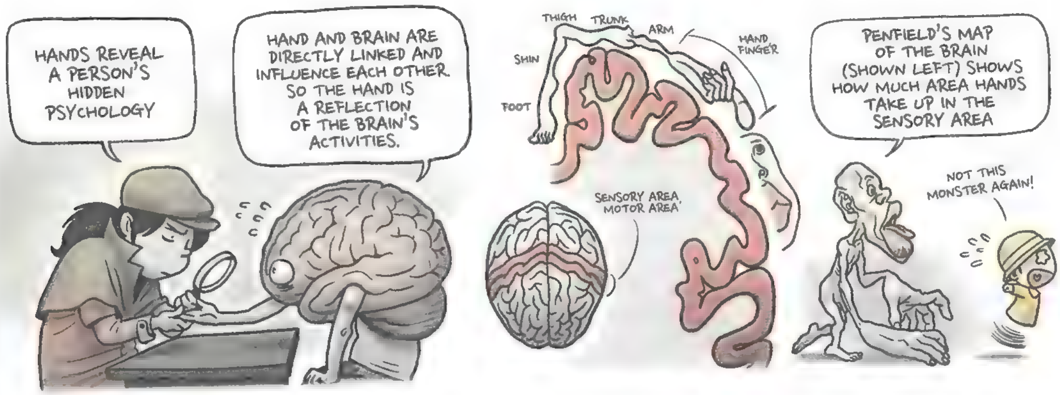


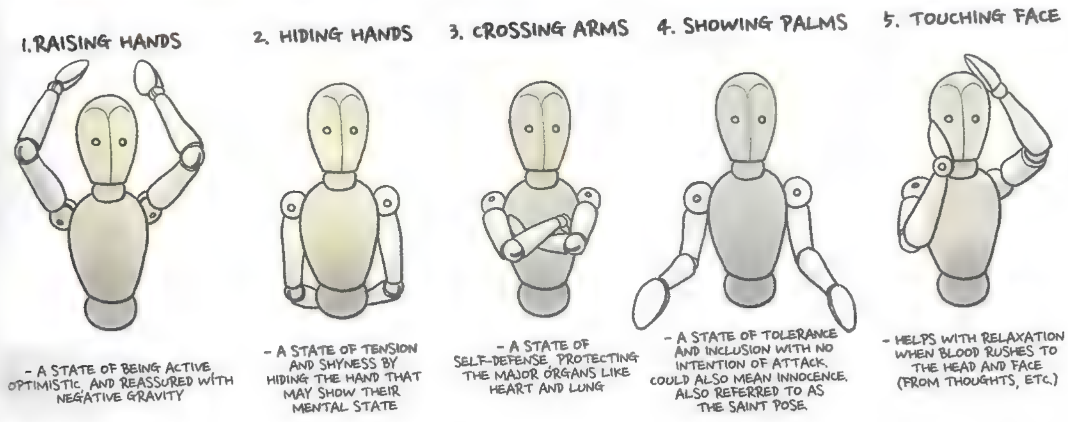
Also, human sensory organs are weaker in function and less durable compared to four-legged animals. The human eye is the fastest aging organ in the body, the nose is the most easily exhausted, and the ear can only process a limited range of decibels. So, the hand needs to be ready at all times to support the facial sensory organs with its tactile senses. That's why the hand is often referred to as the second eye.

We said that the hand is the second eye, but eyes and hands have other similarities beyond senses. Remember, the eye is not only a sensory organ but a medium of expression (refer to page 81), and so is the hand.



In addition to the obvious forms of hand communication like sign language, the hand also reveals our subconscious thoughts. This is because the hand is closely linked to the brain, just like the eye.

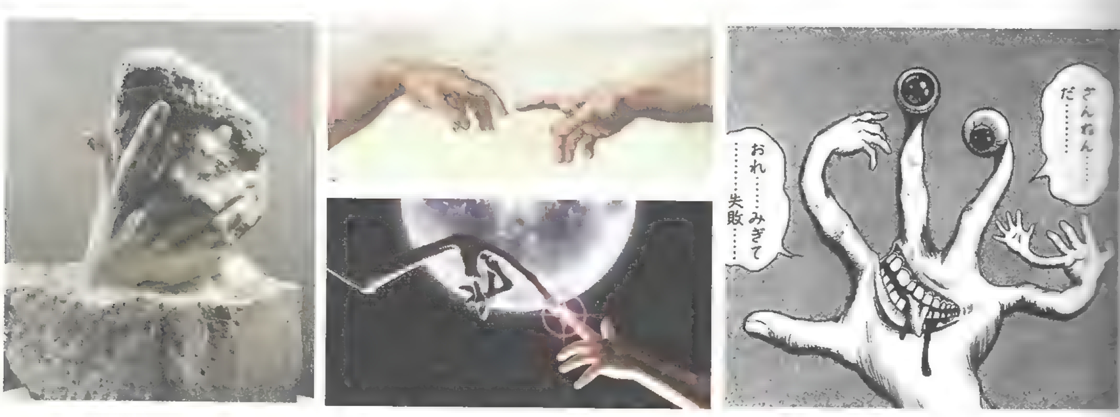




The hand react faster than the brain. The hand moves unconsciously when it protects the body from sudden danger or when it plays an instrument or keyboard. This demonstrates that the hand is its own independent being, despite its close link to the brain.

The movement of the hand in its own subconscious state, like playing the guitar in the diagram, is referred to as 'implicit behavior.' A conscious effort (explicit behavior) must be repeated over a certain period of time for this to take place. Other examples include using chopsticks or typing on the keyboard. Of course, sexual molestation or harassment is a completely separate issue.

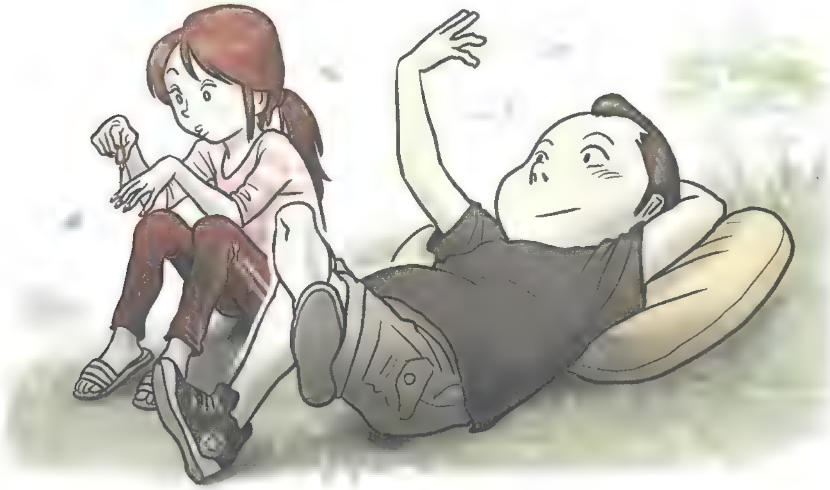
This mysterious ability and external, physical characteristics of the hand have long been a source of inspiration for artists. Painters and sculptures take a keen interest in the role of the hand to bring life into their static works. The hand is like a treasure chest, full of inspiration.



Left: Sculpture "The Hand of God" by Rodin
Top middle: from the painting "The Creation of Adam" by Michelangelo
Bottom middle: Film "E.T", directed by Steven Spielberg
Right: from the series "Parasyte" by Hitoshi Iwaki (published in Kodansha's Afternoon magazine, 1995)

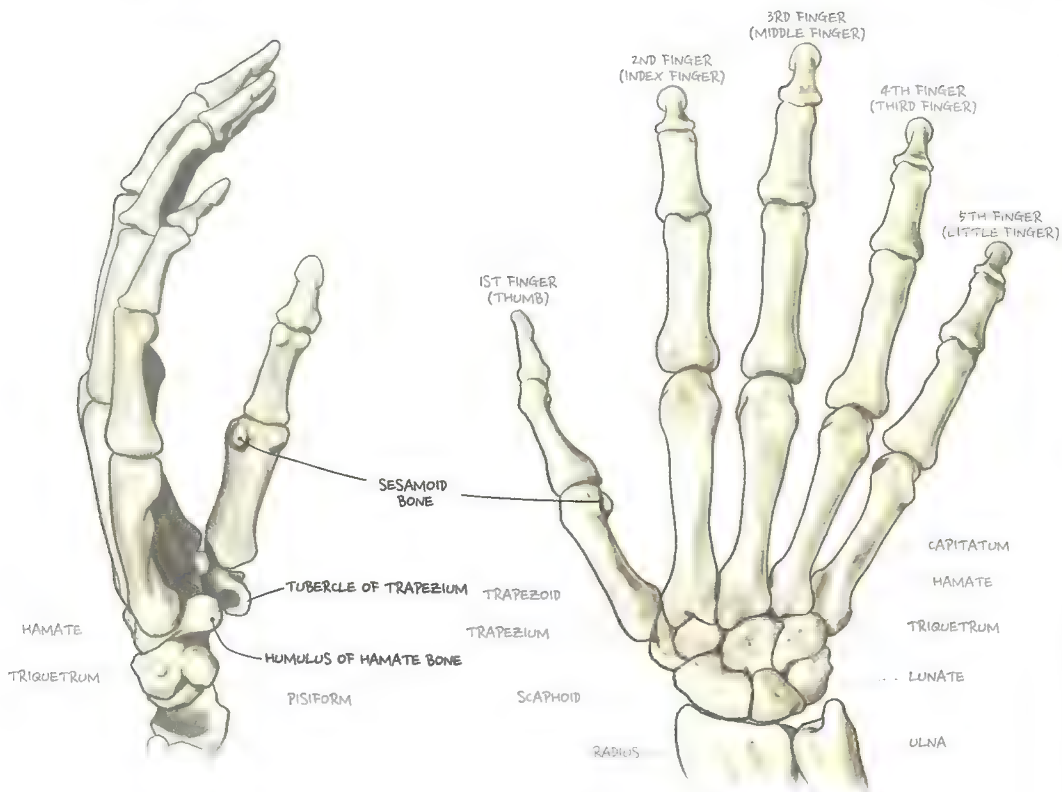
As we have seen, the hand is much more than the most observed part of our body. It would be no exaggeration to say that the hand has led human history with its many roles, senses, and expressions.

Sometimes, the hand tells much more than words.



■Various Bones of the Hand

Below is a diagram of various bones of the hand and their names. I have excluded the parts that we have already discussed.



<Little finger view>　　<BACK OF THE HAND VIEW>

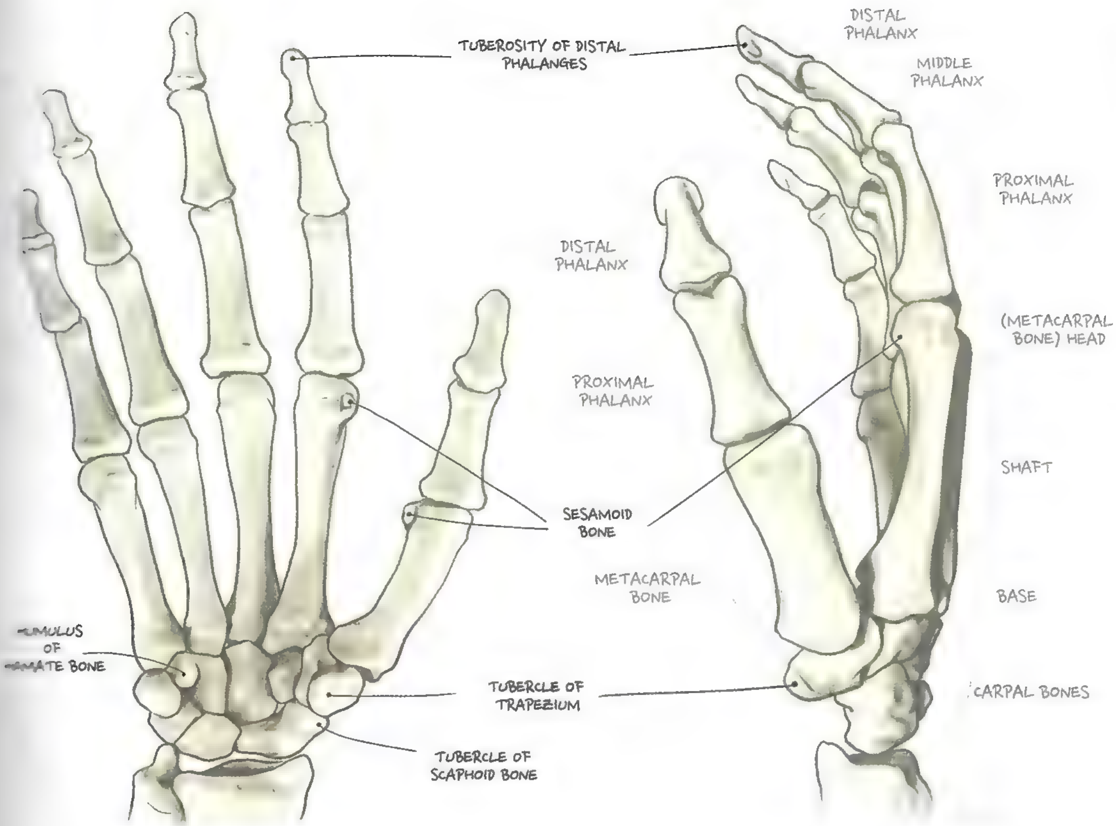
❶ **Sesamoid bone:** Like a seed in a fruit, this bone is as small as the name suggests. It is also "hidden" inside the tendon that moves the hand, just as seeds are "hidden" inside fruits. The sesamoid bone moves only as necessary, thereby reducing the friction between the tendon and bone and acting as a lubricant for joint movement. The patella of the knee is the biggest sesamoid bone in our body.

❷ **Tubercle of trapezium:** The protruding part of the trapezium, the starting point of the first metacarpal bone that is holding the thumb. It is also where the 'flexor retinaculum' of the 'carpal tunnel' (page 392) is attached.

❸ **Tubercle of scaphoid bone:** It forms the radial point of attachment for the flexor retinaculum along with the tubercle of trapezium, and plays a role in the forming of the carpal tunnel.

❹ **Humulus of hamate bone:** The protruding part of the hamate that holds the flexor retinaculum that forms the carpal tunnel from the ulnar side.

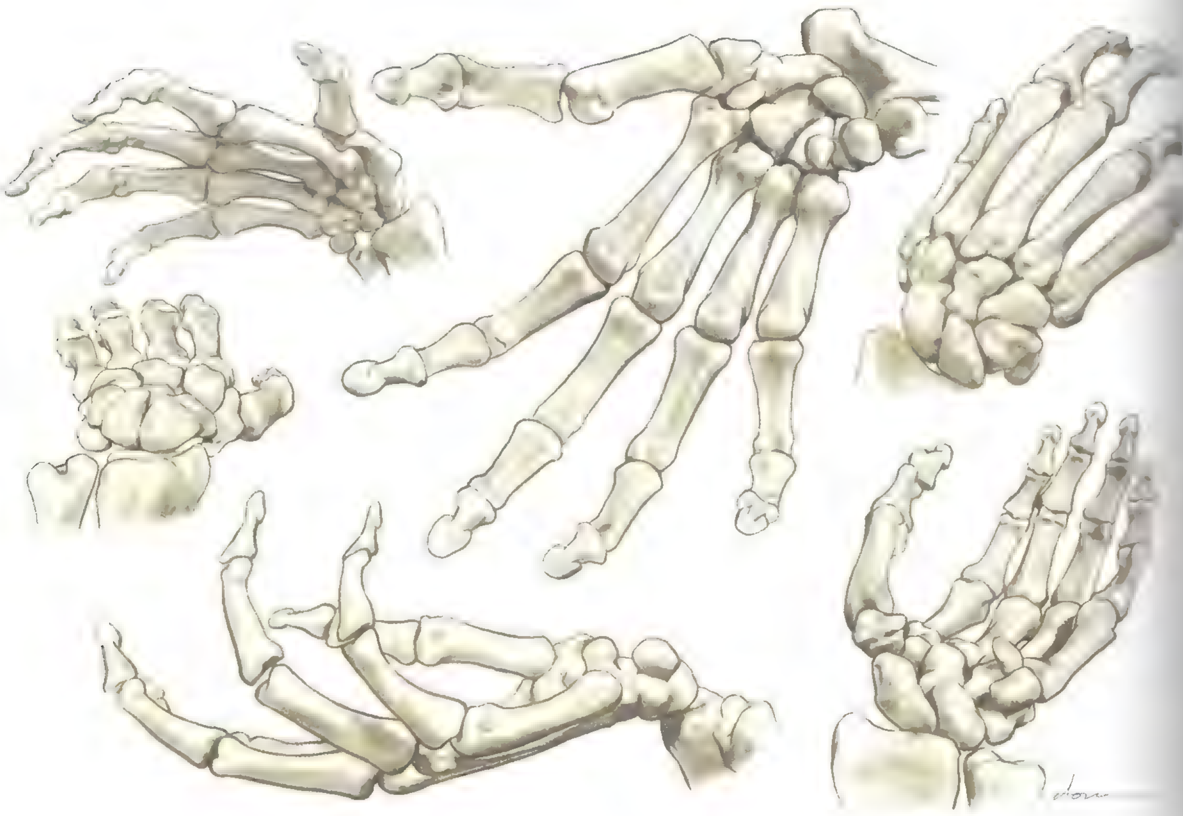
❺ **Tuberosity of distal phalanges:** 'Tuberosity' usually has a rough surface like Velcro so that the ends of the tendon can attach to it. This tuberosity is the place where the tendon of the flexor digitorum profundus attaches to bend fingers.



<PALM VIEW> <THUMB VIEW>

se parts are not as important in terms of drawing or sculpting anatomy parts, but one thing want to point out is that the palm caves in because of the protruding parts (tubercle of ezium, tubercle of scaphoid bone, humulus of the hamate bone) that form part of the carpal nel.

Lastly, the diagram on the right are the bones of the hand. The diagram includes the thumb, from various angles. Finally, we have something that actually looks like the hand we know. But if it still looks complex, just remember the three parts of the hand – carpus (wrist), metacarpus and phalanx (fingers) and their joints and boundaries and take a good look at the diagram.



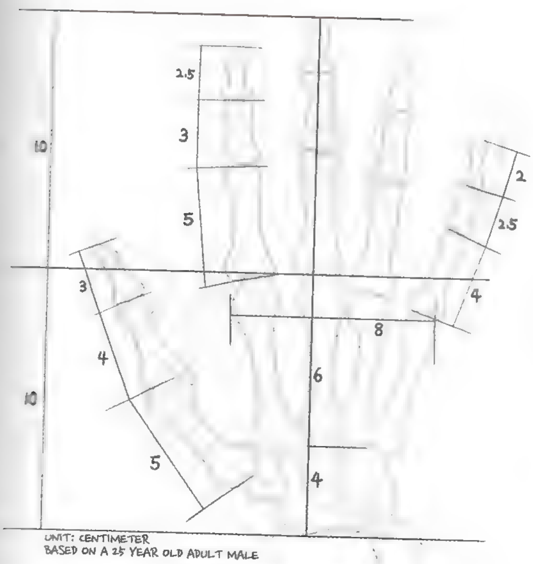
Is it still too complex? If it is, that's okay. We're still learning.
Don't worry, and follow me to the next section.

Let's Draw the Hand

So far, we've learned about the different bones that shape the hand, but we learned about the bones to gain a better understanding of the hand. A greater understanding allows us to portray it more vividly. It's no use knowing all these bones if we can't put together the whole hand.

Of course, we could always go more in depth and learn more, but I think we've learned enough about hands to draw it properly. So just as we have done so far, just keep cool and go through the steps slowly.

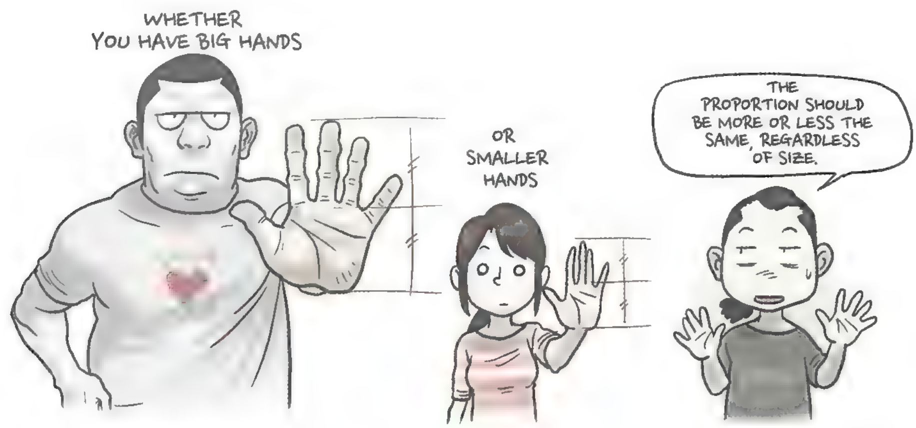
❶ Proportion of Hand



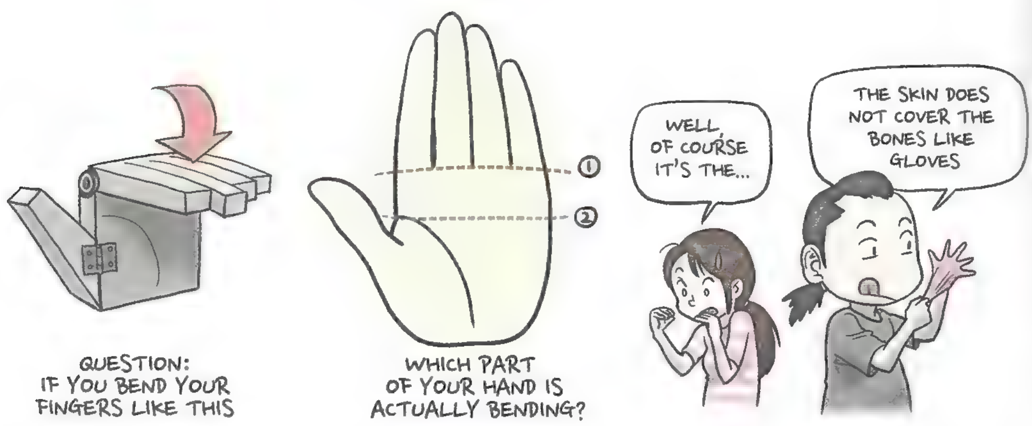
Before we start drawing the hand, we need to go beyond looking at the size of individual bones and start by looking at the overall proportion of the hand.
The diagram on the left shows the proportion of the hand of an average 25-year-old male. It's hard to grasp, right?

Well that's natural. Everybody's hands are different in size, and we're not used to understanding body parts in numbers.

Even things in nature follow a certain order or rules to maximize their chances of survival and efficiency, even though they may appear irregular. In other words, there is a secret to the proportion that allows for the hand's various movements. So, rather than looking at the measurements, pay more attention to the proportions. What does this mean?



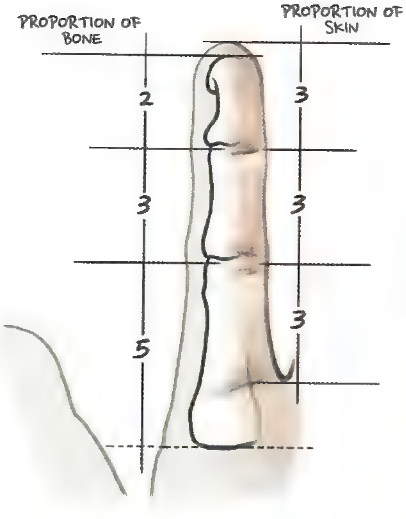
That sounds nice and all, but the problem is…there is a slight difference between the proportio of the hand bones and the proportion of the hand that we see. Some of you may wonder then why we bothered looking at the bones instead of diving right into the proportion of the hand itself. But as you may have noticed, the hand is so complex that it's hard to understand proper without knowing the structure of its bones. Let me explain with an example:



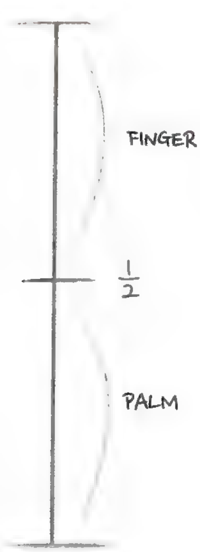
This question is essentially asking about the starting point for fingers, or metacarpophalangeal joint. Most people choose "1", where fingers start to separate, as the point at which fingers start, but the correct answer is "2." (Try it now and see for yourself!)

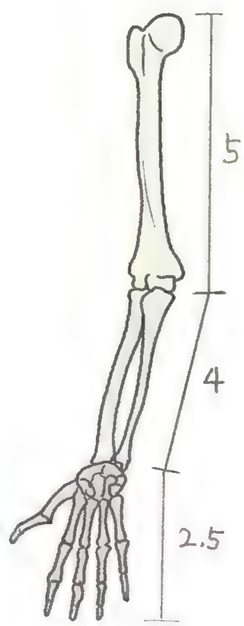
This misconception arises from the difference between bone and skin proportions.Moreover, the various curves and creases of our hands are affected by bones, and that's why we started with an understanding of the bones and their proportions.

So, as you read ahead, please do keep in mind that the hand that we're drawing is based on bone proportions. Okay, do you have your pencil and paper ready?



❸ Drawing the Bones of the Hand



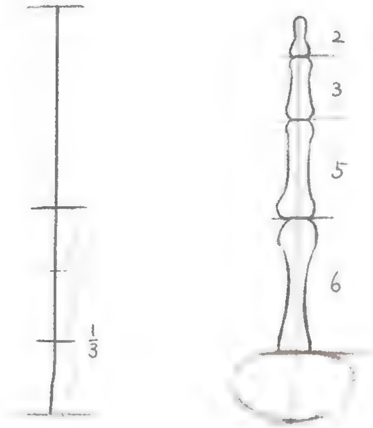


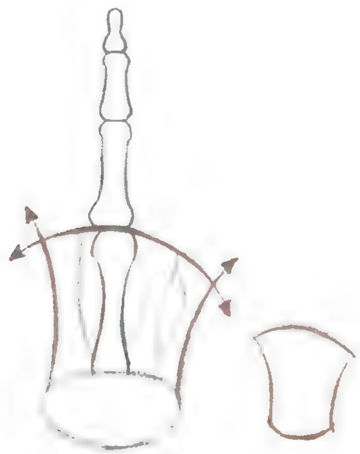
01. Draw a vertical line and mark the halfway point, dividing the finger from the palm of the hand. This median line acts as reference for all other fingers, because this is the longest finger of the hand. Above this line is the middle finger (the third finger), and below it is the domain of the third metacarpal bone.

Make note of the drawing on the left for guidance about arm and hand proportions.

02. Divide the palm area into three. The lower third is the domain of the carpal bones. We've learned previously that the carpus is made of eight different bones, but here we will just show it as one big oval. (The two-thirds point above the carpal bones becomes the domain of the middle metacarpal bone.)

From the middle of the carpus, draw the metacarpal bone, the first proximal phalanx, the middle phalanx, and the distal phalanx in order using 6-5-3-2 proportion in the upward direction. *In other words, the bones of the hand get shorter the further they are from the body.*

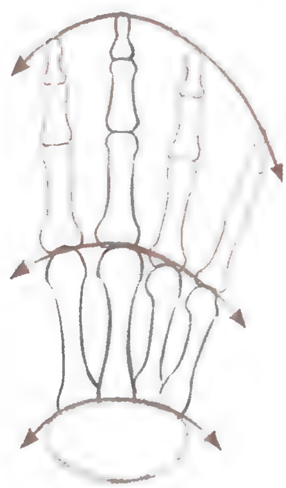


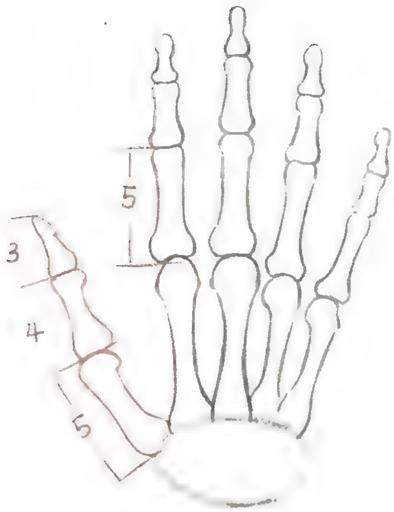


03. Like the drawing on the left, draw the second to fifth metacarpal bones like an open fan. The second metacarpal bone is the longest and the fifth is the shortest, so the drawing should look somewhat like an asymmetric cup or the blade of an axe that is slightly lower on one side.

04. Draw each of the phalanx bones above the metacarpal bone. The length of the phalanx bones will each be different, but the proportion will still remain 2:3:5.

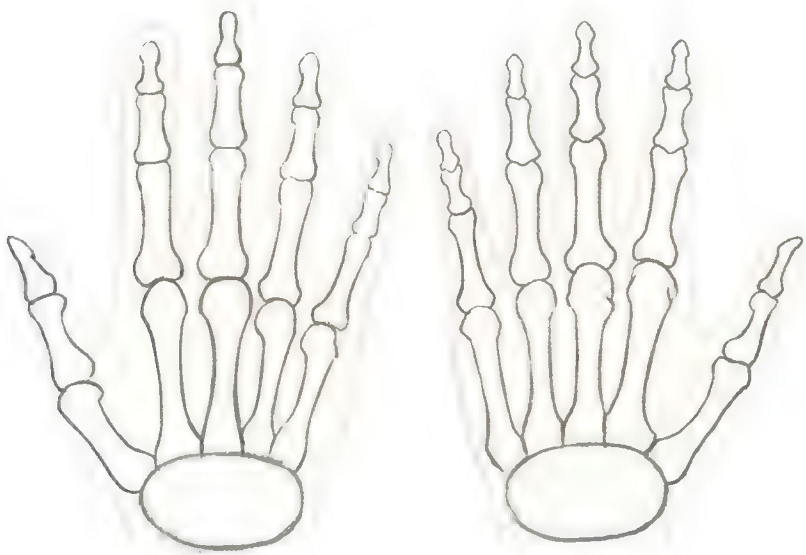
Also, don't forget that the slope of the arch gets steeper as we move outward from the wrist to the fingertips.





05. Draw the metacarpal bone and phalanx of the thumb (the first finger) facing towards the index finger (second finger).

The entire length of the thumb, including the metacarpal bone, is slightly shorter than the middle finger (third finger), and the length of the metacarpal bone of the thumb is almost the same as the length of the proximal phalanx of the index finger. If it's too complicate, just think of it as drawing another thumb - but be sure to draw it from the side, not the front, to enable opposition.

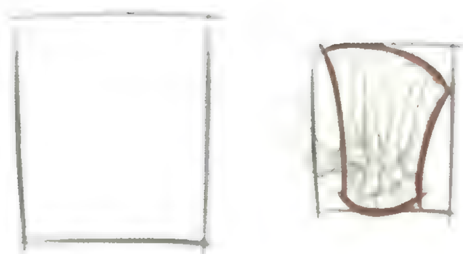


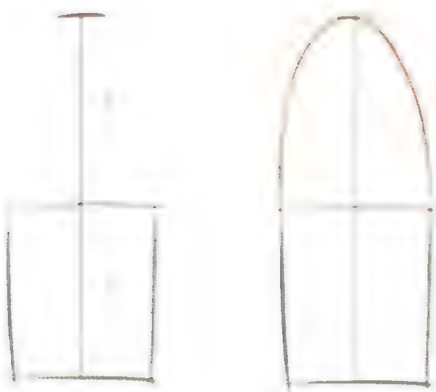
06. Once you've drawn the thumb, you have completed drawing the hand bones. The back of the hand is drawn in more or less the same way, but just bear in mind the difference between the bones and the skin covering the bones (especially where the fingers start to separate). Pretty easy, right? If you thought it was hard, it's probably because we were paying attention to the proportion. Once you get the hang of it, it won't be as hard. If it's still difficult, just remember one thing - bones in the finger get shorter as you go further away from the body.

❸Drawing the Palm of the Hand

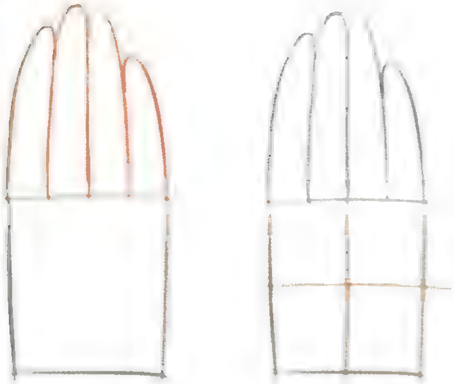
Now that we've drawn the bones of the hand, let's draw the actual hand. Just a little warning that drawing the hand will be a different process than drawing the bones. That's because the hand is affected not only by the bones inside but also the muscles and tendons that make it move. So let's take this one step at a time, comparing each step with the bone drawing process.

01. First let's draw the palm, which is considered the root and stem of the hand. Whereas the bones formed a narrow trapezoid, resembling the blade of an axe, the palm will be closer to a square.





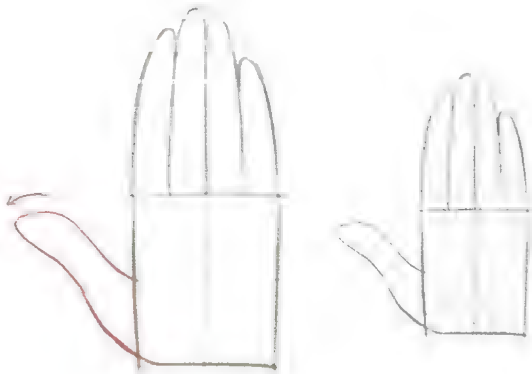
02 Extend the line above the 'square,' as much as the height of the palm, and draw an arch at the top of the line to complete the zone for fingers. Be sure to draw it slightly lopsided (toward the thumb). We are going to draw the thumb on the left side, so the arch is leaning slightly toward the left.

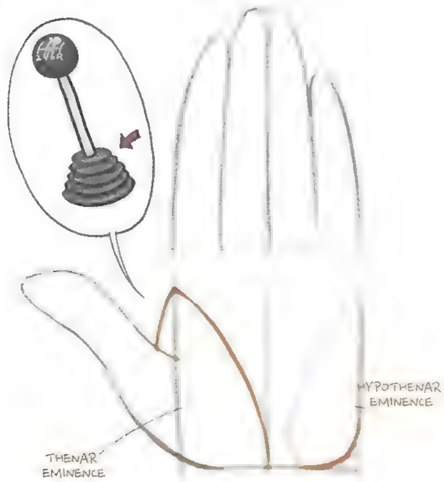


03. Draw fingers inside the arch. Since the arch is leaning toward the left, the little finger is naturally going to be the shortest, while all the fingers point slightly toward the middle. Now that we've drawn in the fingers, let's draw a horizontal line in the lower square and divide the palm into four sections.

04. Draw the thumb from the lower left quadrant. Unlike the other fingers that are converging toward the middle, the thumb points outward as if it's running away.

So far we've drawn the hand using the proportions of the bones. Although it is starting to resemble a real hand, we're still not quite there.

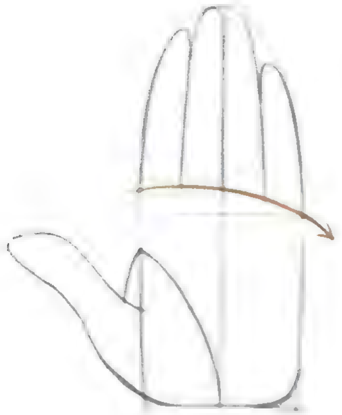




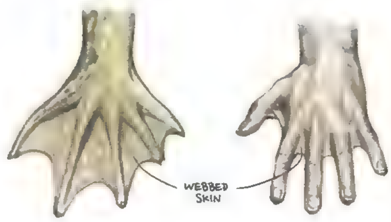
05. Indeed, as I mentioned earlier, there are more details in the hand because of the thickness of the skin. So next we will draw in the skin of where the thumb joins the palm. This part, referred to as thenar eminence, sticks out because of the muscles that flex or pull the thumb inward. It resembles the rubber dust cover boots of gear shift levers in manual cars. (Refer to diagram)

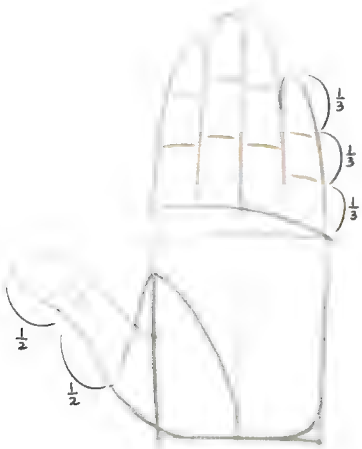
There is also a hypothenar eminence for the little finger, but it doesn't stand out as much as the thenar eminence so it can be drawn simply by rounding the edge of the palm.

Also, the thenar eminence will cause a crease in the middle of the palm called the thenar crease, also commonly referred to as the life line.



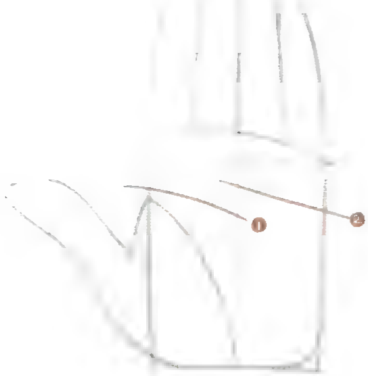
06. The point where the fingers separate is actually a little bit higher up. This is because of thin layer of skin between the fingers, like the webbed feet of a frog. (Refer to below diagram)Thus, the length of the fingers is slightly shortened compared to the bone diagram and the metacarpophalange joint, the line where fingers start and the crease where fing bend, is located inside the palm.

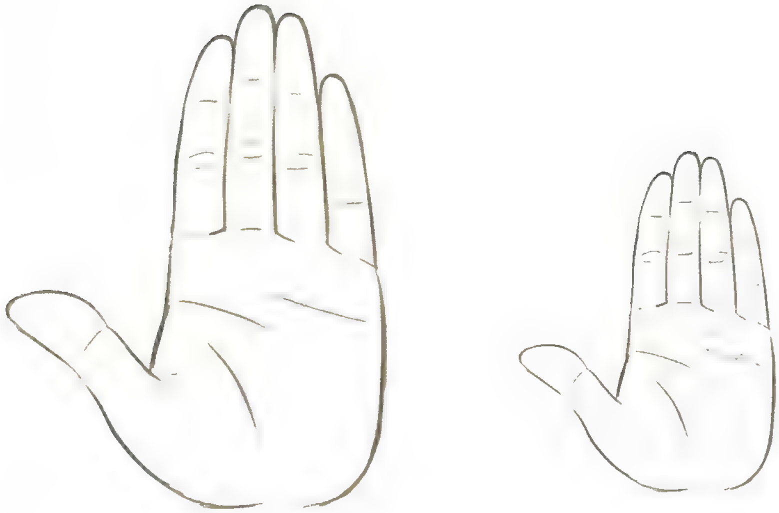




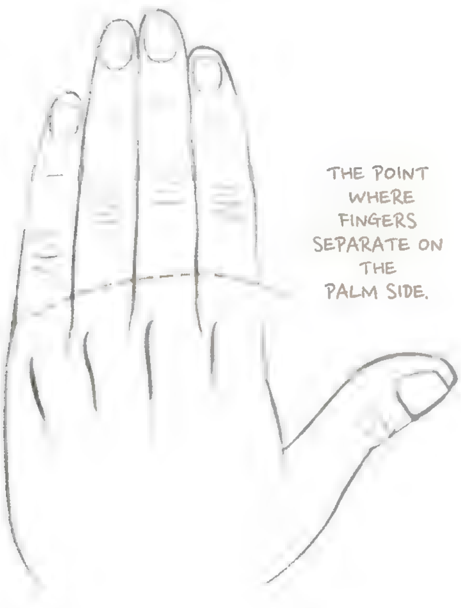
07. let's now divide the joints of the fingers. The bones follow the Fibonacci sequence and fit the 2:3:5 golden ratio (refer to page 397), but the thickness of the skin at the tip of the finger and the webbed skin makes the ratio closer to 1:1:1. The ratio of the proximal and distal phalanges are the same for the thumb as well.

08. Just one more thing. Draw a horizontal crease on the palm between the base of the thumb and where the fingers separate. Line 1 is called proximal transvers' and 2 is called distal transverse. This crease is the milepost for metacarpophalangeal joint where fingers bend.





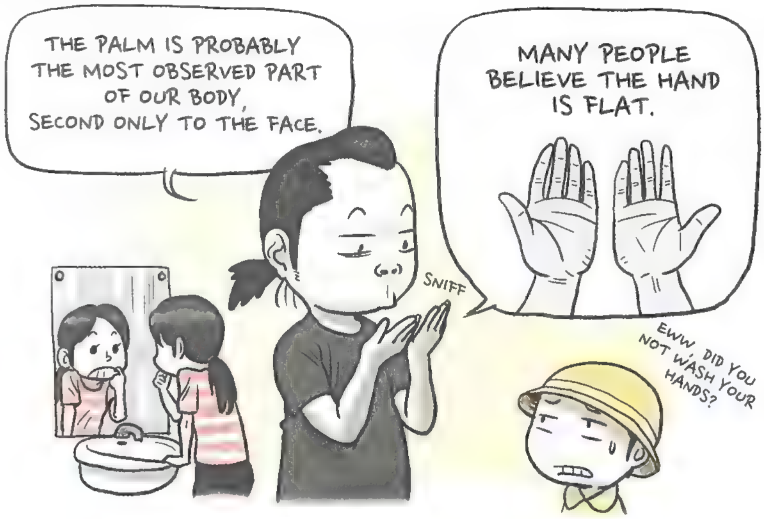
09. Take the sketch and round out the edges to complete the drawing. Compare the drawing and the proportions to that of the bones of the hand (drawing on the right).



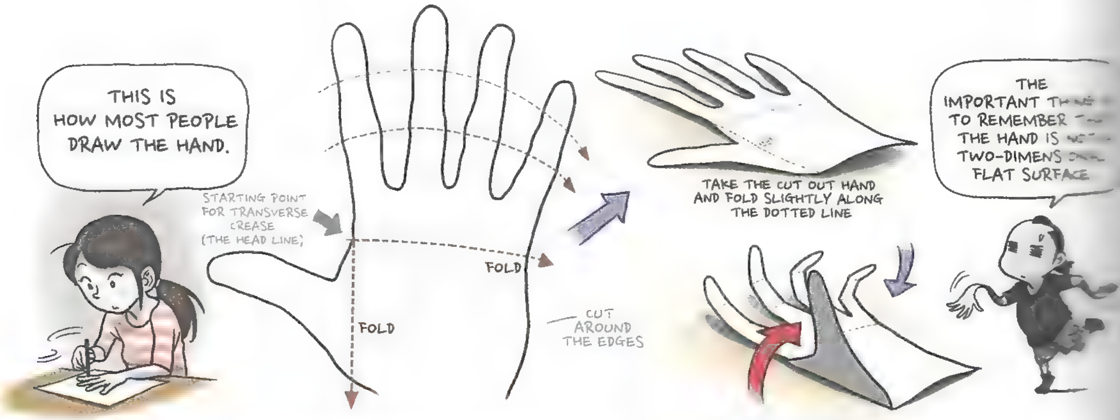
10. When drawing the back of the hand, the process is the same up to step 4 but the fingers separate at a lower point and is aligned with the starting point of the metacarpophalangeal joint. That's why fingers look longer when looking at them from the back of the hand compared to the palm.

Basic Position of the Hand

We usually think of the palm when we hear the word hand. That's probably because the insi the hand directly touches objects and is used to grab or hold things, and we check the palm our hand habitually throughout the day without realizing.



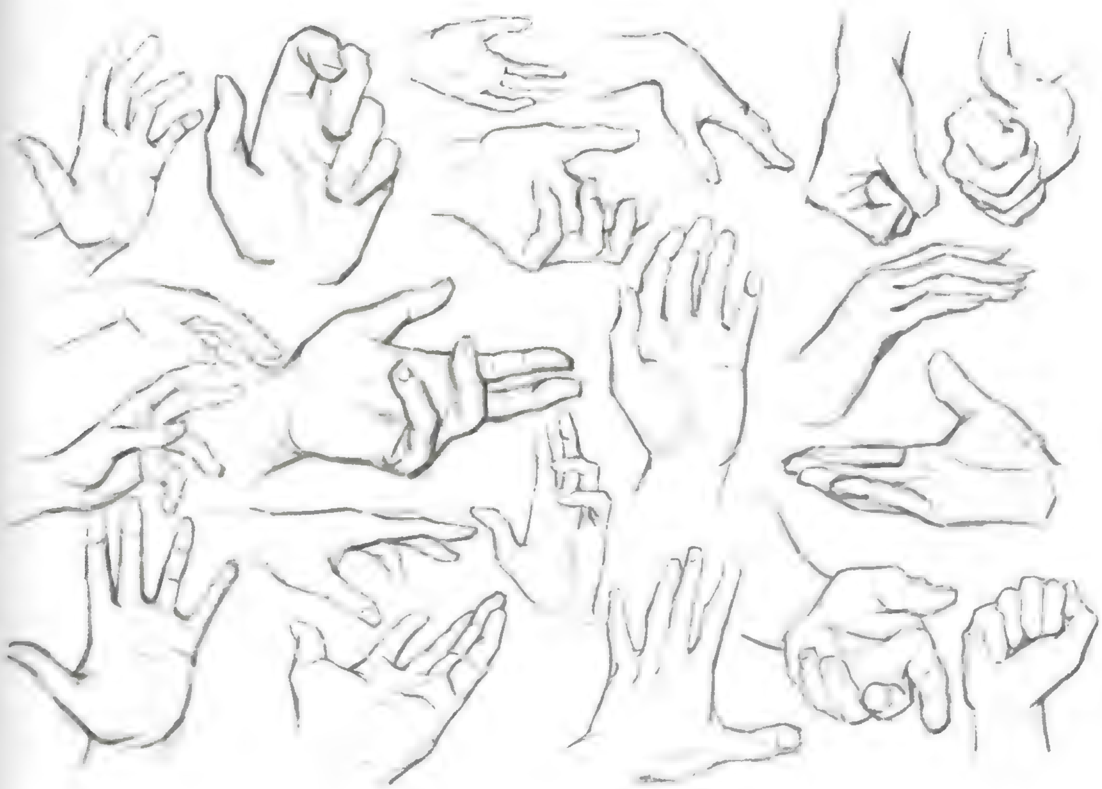
Just give it a little thought and it's easy to realize that the hand is not a two-dimensional flat surface. But regardless, we tend to think of the hand as being flat because that makes it easier for us to remember. Of course, there is nothing wrong with that. It's only human nature simplify complicated things to help us understand.



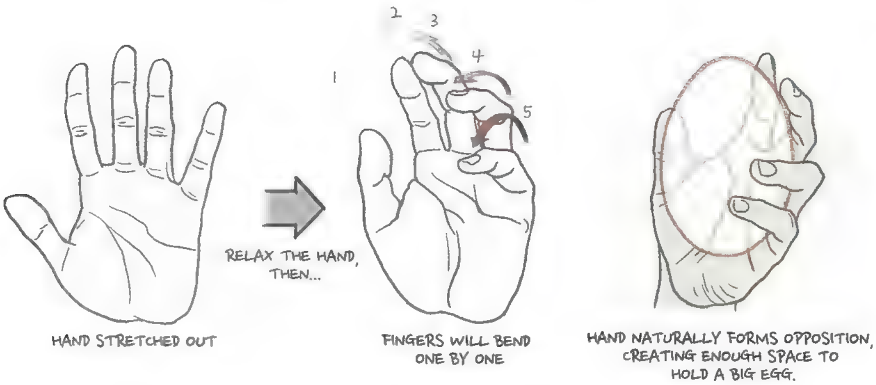
<COMMON IMAGE OF THE HAND>

So when we draw the palm on paper, it may be the 'basic form' but it is hardly the 'basic position.' It's just not natural to see the hand stretched out so flat.

So what is natural for the hand? The following are all the expressions that a hand can make. There are many variations, but if you look closely you'll get an idea of an 'average.' The average is what is the most natural for the hand.

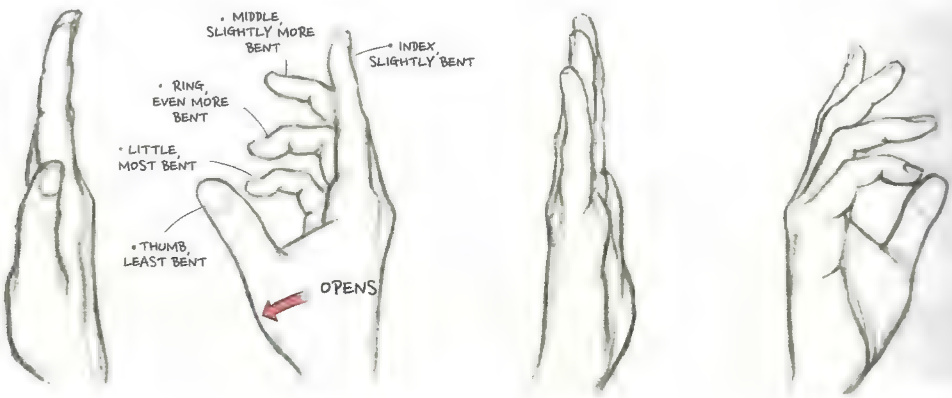


Still having a hard time grasping the concept? Then just put the book down and see for yo

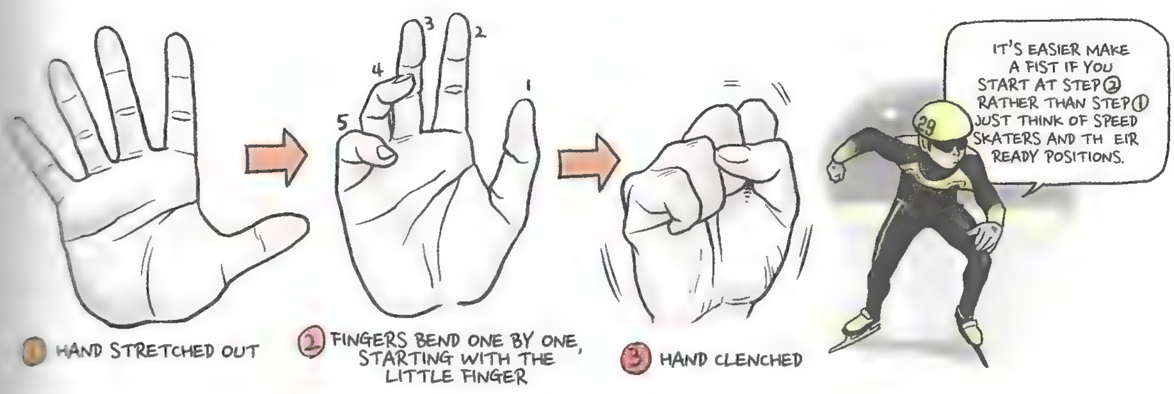


It's easy, right? Of course, everybody's hand will look slightly different but for most people, th fingers will be slightly bent toward the palm as if holding a big egg. Observe this shape ca and try to remember it. This is the most natural 'basic position' of the hand.

If you take a closer look, you will see that each finger is bent at a different angle. Starting w the straight-lined thumb, each of the fingers bend slightly more toward the palm so that by th time you get to the little finger it's bent to form the letter C. The base of the thumb opens up a creates a more distinct arch for the carpal tunnel.

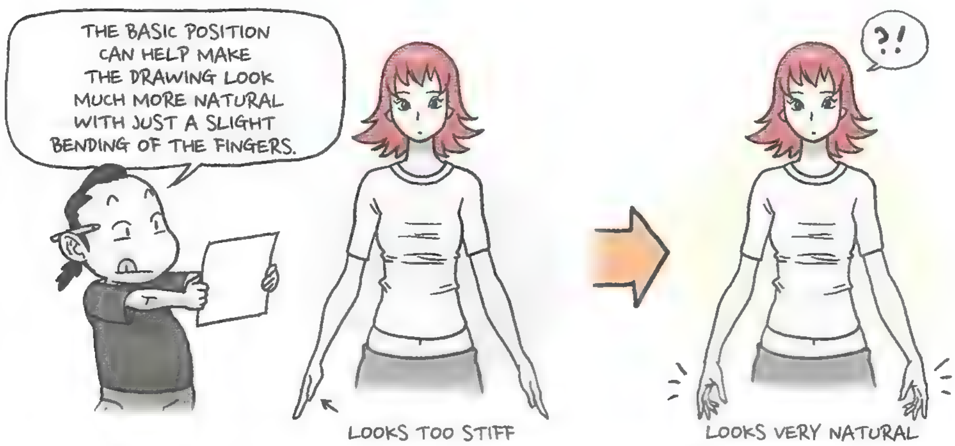


There is no clear explanation as to why the fingers bend like this when the hand is relaxed. But one thing is clear—it makes it really easy for the hand to clench a fist. Also, the grip is stronger because the fingers bend inward and at the same time the thumb locks in the index and middle finger. *So the hand maintains the basic position, unless you make a conscious effort to stretch it out.*



The basic position is one of the forms that the hand naturally takes in the process of clenching a fist.

In addition to the functionality, the basic position is also a powerful tool to portray various situations and poses.



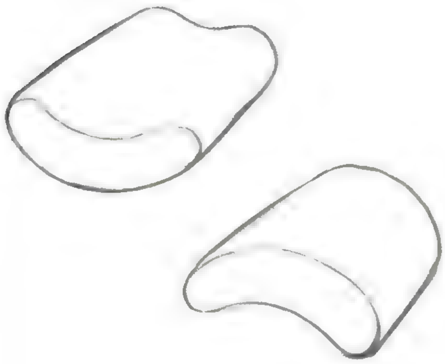
Apply the basic position when drawing the character sheet for characters in games or animations.

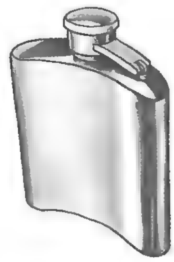
Various applications of the basic position.

The hand can express many different movements but the 'basic pose' of the hand looks like a very loose fist. So, if you familiarize yourself with this basic pose first, the remaining variations will come easier. Therefore, if you are still struggling to draw the hand, just focus and practice repeating the 'basic pose.' I guarantee that it will pay off (I feel like I'm selling snake oil). When you adjust the hand pose of expensive plastic model toys, you will see a big difference if you adjust them into the 'basic pose.' You will understand that the biggest difference in appearance between a human and figure comes from the hand. The truth is that what is most basic is also most important.

Drawing the Basic Position of the Hand

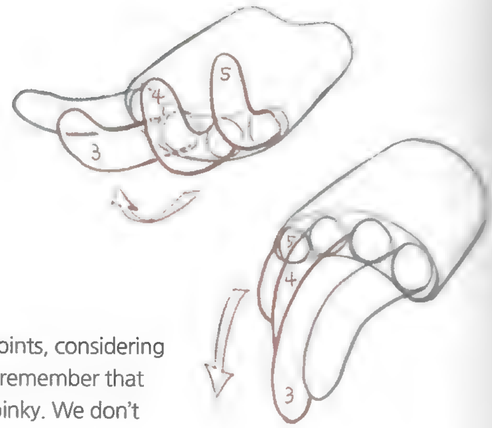
So let us now draw the basic position of the hand. Unlike the palm, we will draw it at an angle as if we are looking at the hand from a mirror. But even with the different perspective, the drawing process is very similar to drawing the palm so be sure to familiarize yourself with that before you proceed. Ready to start?



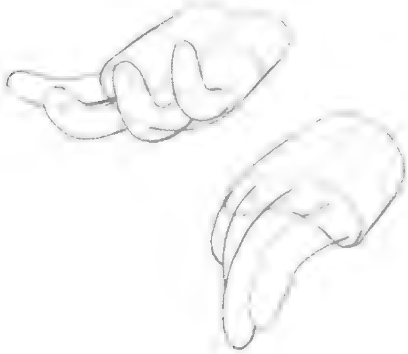


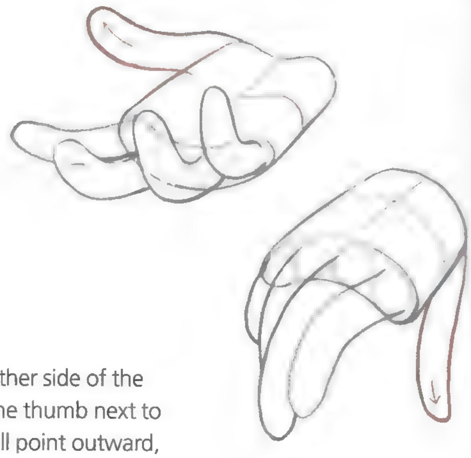
01. First, draw the palm. It should almost look like a hip flask with the big curve in the middle, with the palm side being concave and the back of the hand being convex.

02. Next, we'll draw in the fingers. Start by marking the base of all the fingers except the thumb. The fingers will extend from these points, and keep in mind that the fingers will bend toward the palm of the hand.

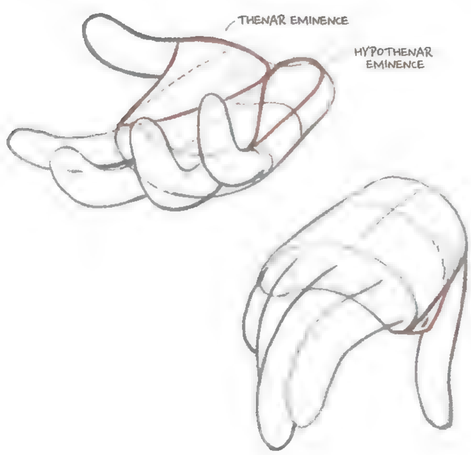


03. Draw the fingers from their respective starting points, considering the length of each finger. Start at the index and remember that the fingers bend more as they get closer to the pinky. We don't worry about the joints at this point.

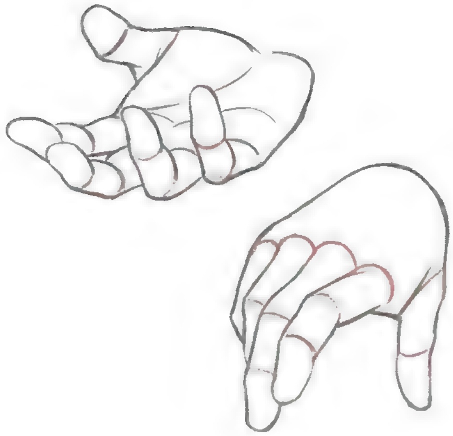




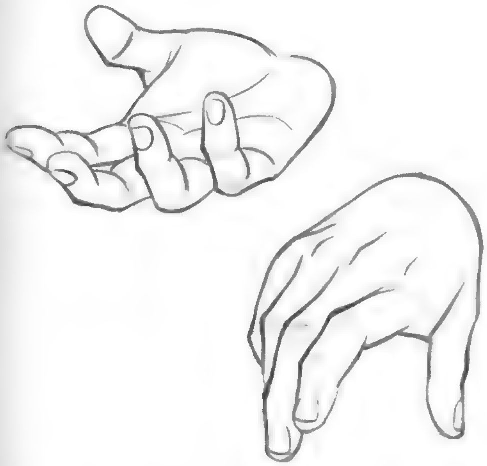
04. Now we will draw the thumb. Draw a cross on either side of the hand to divide it into four quadrants, and draw the thumb next to the index finger. Keep in mind that the thumb will point outward, compared to other fingers that point toward the palm.



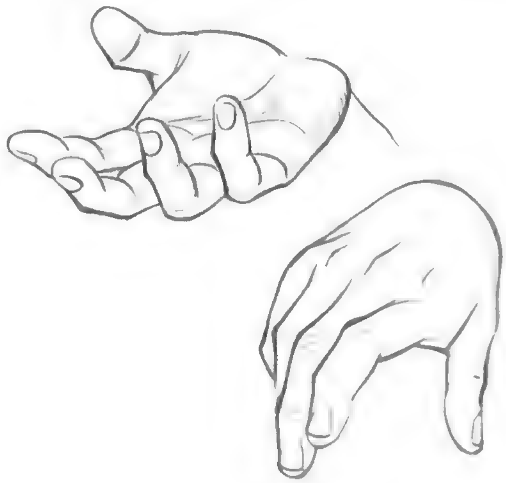
05. Mark the zones for thenar and the hypothenar eminence in waterdrop shapes. They become important mileposts because they make the hand appear three-dimensional.



06. Mark the joints of the fingers.



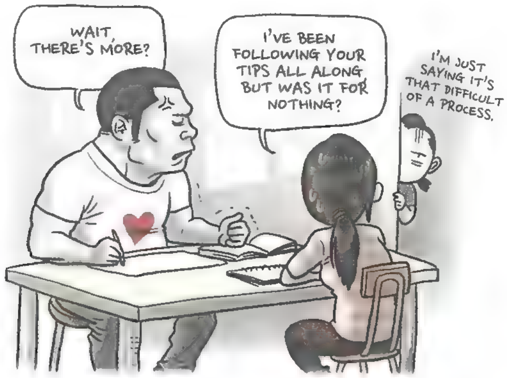
07. Draw in the creases and wrinkles of the finger joints, and the protruding parts of the head of the metacarpal bone on the back of the hand.



08. Erase the sketch lines carefully, and put finishing touches on the outer line to complete the drawing.

Checklist for Drawing Hands

In addition to the way of drawing the hand we saw before, there are many more drawing techniques out there on the internet. It may seem like you sort of understand at the time, but reality is that it fades so quickly afterwards. If our tips were enough to make you a pro at drawing hands, it would be so easy for us to all become artists.

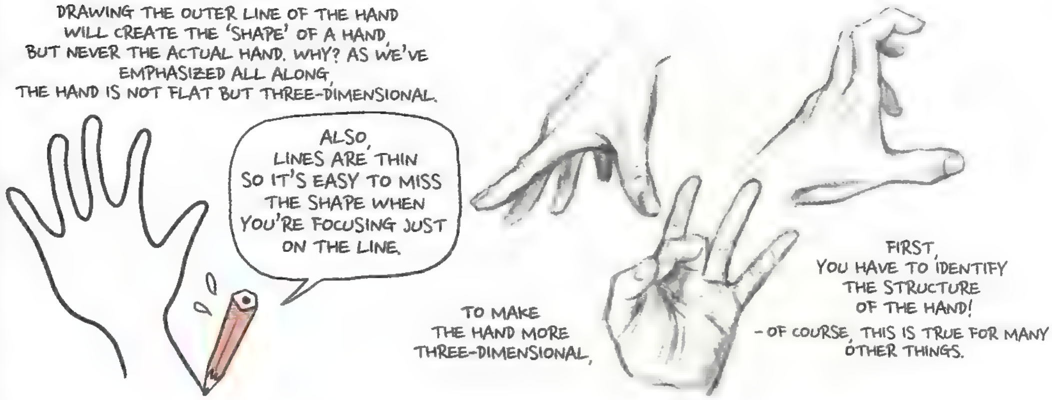


The biggest difficulty in drawing the hand is that it is one of the most exposed and familiar parts of our body, along with the face. Because we're so familiar with the hand, drawings will look really awkward even if we miss the tiniest of details. Familiar subjects have that much more meaning and significance to us.

That's why we have come up with a checklist of details to check when drawing the hand.

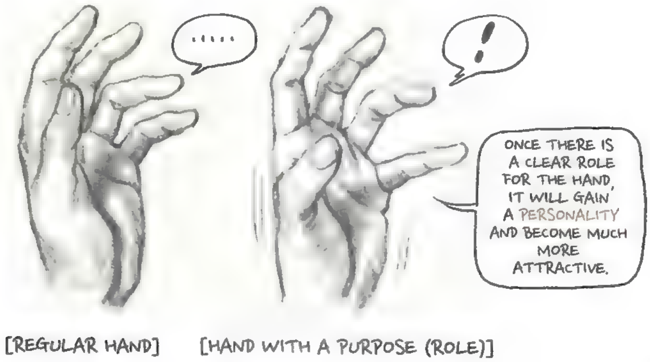
❶ Think about the structure of the hand

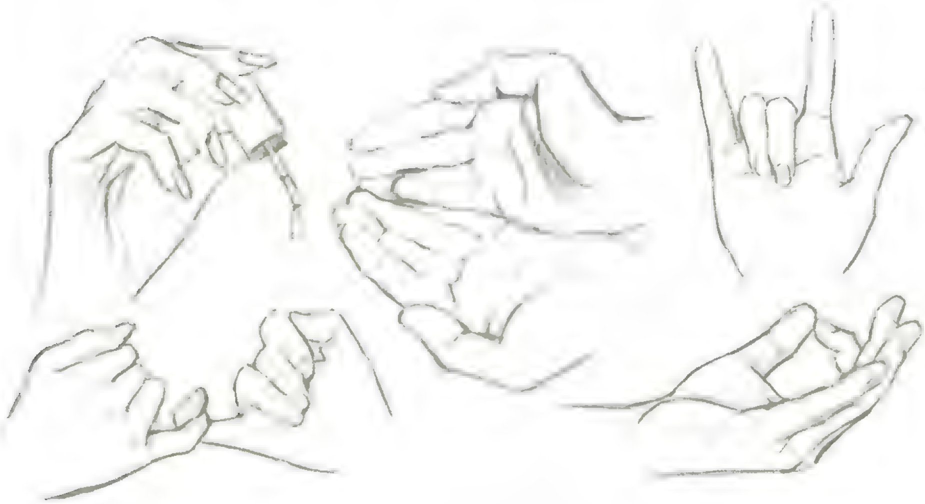
We have a tendency to draw only the outer line of the hand. After all, pens and other writing tools we use have pointed tips for us to draw lines. But even though you're drawing a line, keep in mind that the subject of your drawing is in essence not a line.



❷ Think about the role of the hand

Our hands are always doing something, never resting. So a hand that is doing something will always feel more lively compared to a hand that is just existing conceptually.



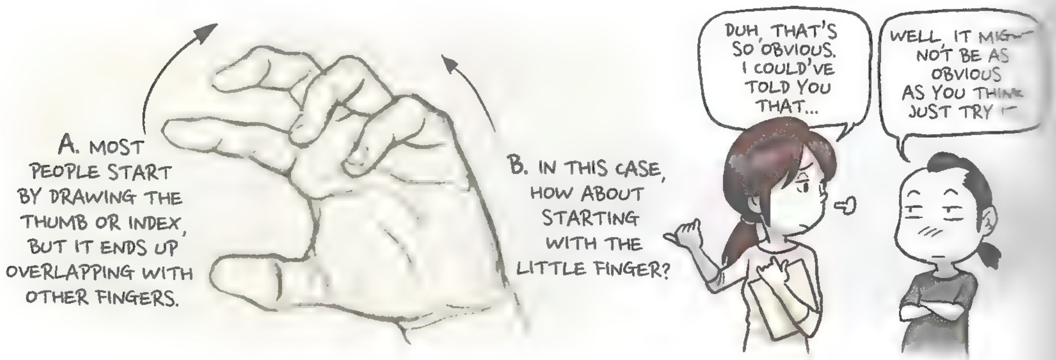


Various images of the hand with a clear role

Having a clear role for the hand also makes it easier to draw the arm. As we explained ea
arm just follows the hand and supports it.

❸ Change the steps

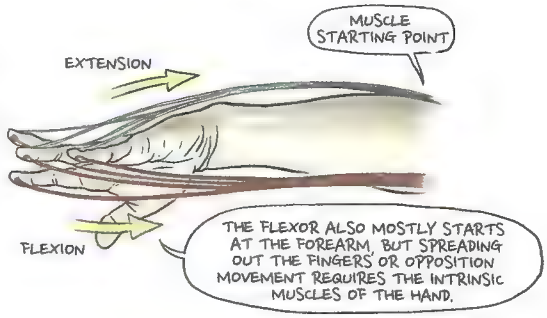
Lastly, this is a tip that I find particularly helpful. Many people start drawing the hand from the thumb and index because they are the most important parts. But sometimes it's better to them at the end because they are so important. I know some of you are probably questioning the validity of this so-called tip, but just trust me and try it out. Even if it doesn't work for you, always good to try breaking away from the norm.

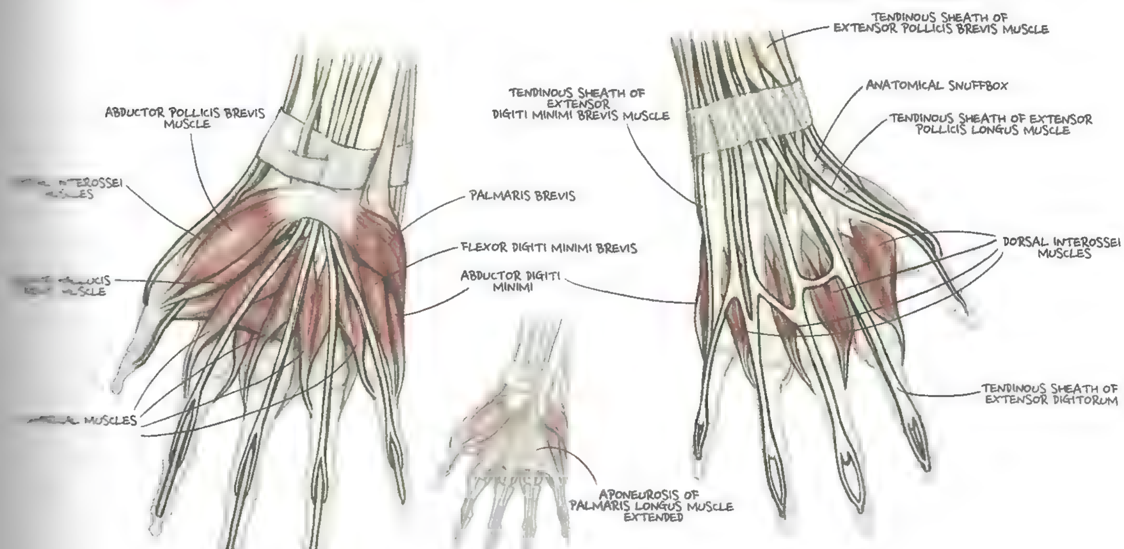


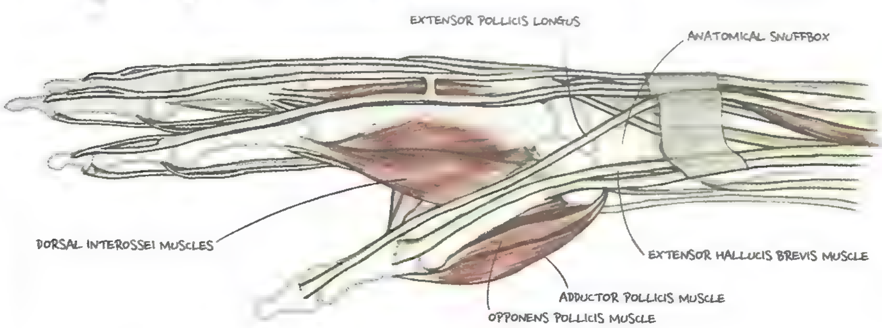
The three points of this checklist isn't just for drawing the hand. They can be just as easily a when drawing other parts of the body, landscape, or objects. But even with all the tips in the world, the most important thing is to never cease to be curious about the things going on ar you and try to take an objective perspective. At the end of the day, drawings are products o view of the world.

Muscles of the Hand

Many of the muscles that move the hand or the finger start at the forearm, as we have seen before. But spreading out the fingers or movements like 'opposition' require muscles. Muscles that are attached to the hand itself are called intrinsic muscles, and have only flexor and abductor, and no extensor. Although they do not have a big effect on the external appearance of the hand, we should still go over them.

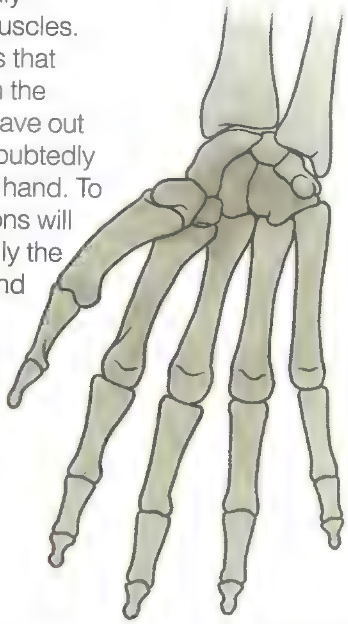




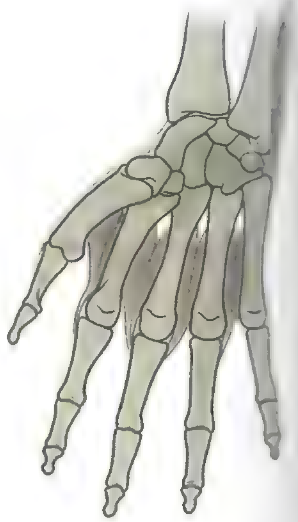


■Let's Add Muscles to the Hand

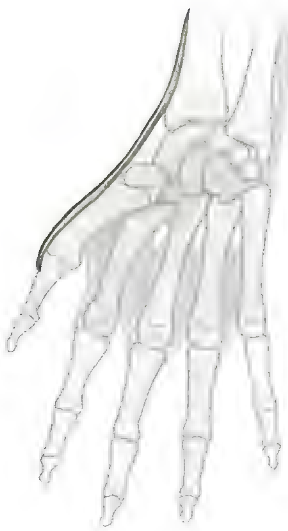
Even though the hand has many complex features, it actually doesn't have that many muscles. But then there are tendons that run down to the hand from the forearm, which we can't leave out because they are still undoubtedly one of the elements of the hand. To avoid confusion, the tendons will be marked in blue, and only the intrinsic muscles of the hand will be marked in red.



❶ bones of hand



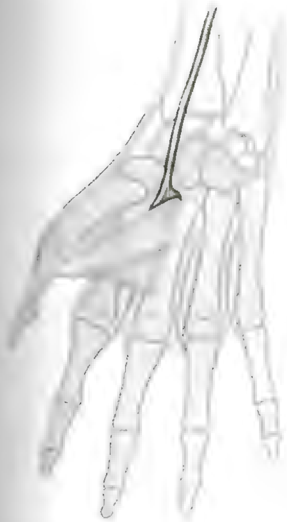
01. Extensor pollicis longus/ dorsal interosseous/ extensor digiti minimi



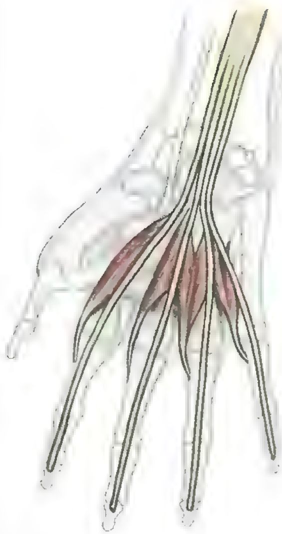
02. Extensor pollicis brevis

03. Palmar interosseus

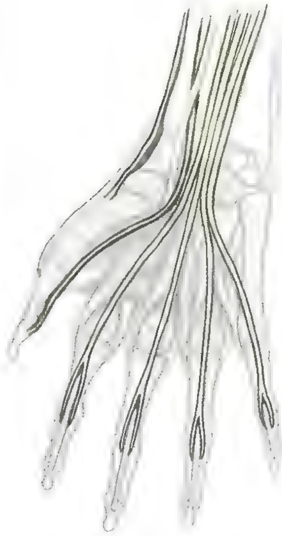
04. Adductor pollicis



05. Flexor carpi radialis



06. Flexor digitorum profundus/lumbrical



07. Abductor pollicis longus/flexor pollicis longus/flexor digitorum superficialis

08. Opponens pollicis, opponens digiti minimi

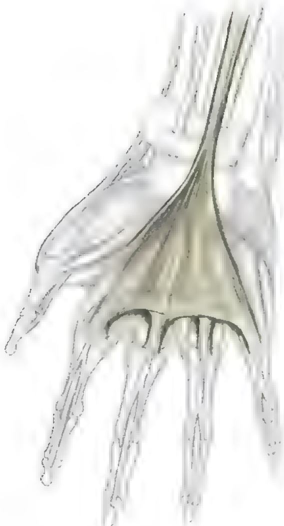
09. Flexor digiti minimi brevis/abductor digiti minimi

10. Flexor hallucis brevis

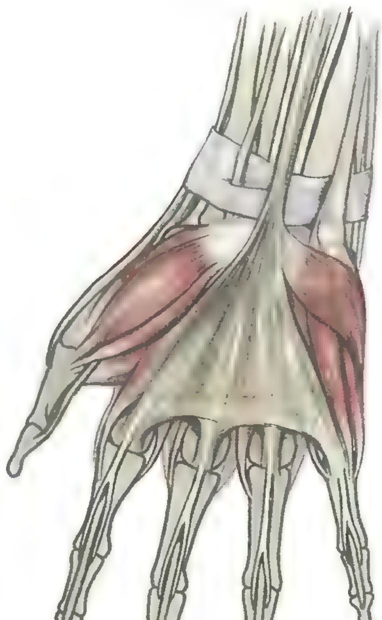
11. Abductor pollicis brevis

12. Palmaris brevis

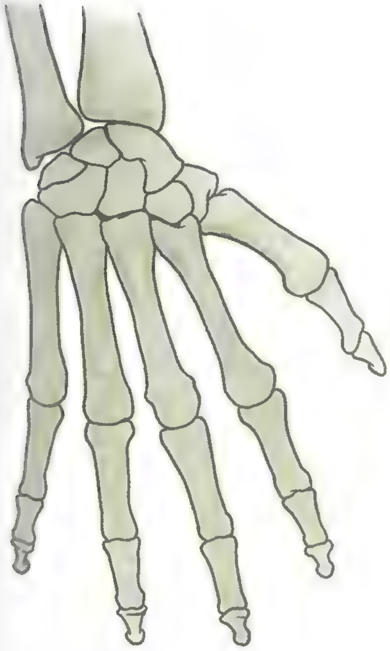
13. Flexor retinaculum



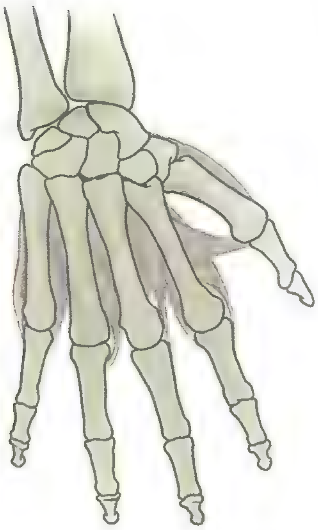
14. Palmaris longus



15. Palm complete



❷ Bones of hand

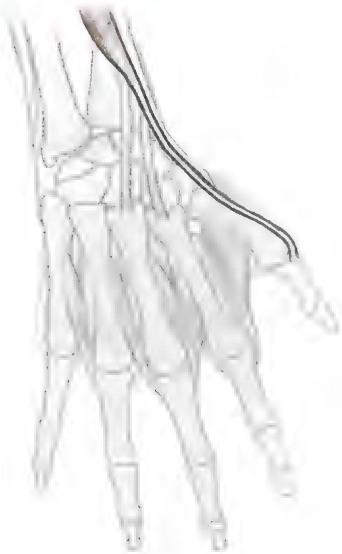


01. Extensor digiti minimi

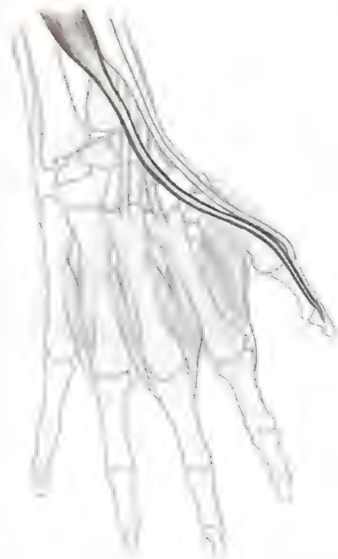
02. Dorsal interosseus

03. Extensor carpi ulnaris/ extensor carpi radialis brevis/extensor carpi radialis longus

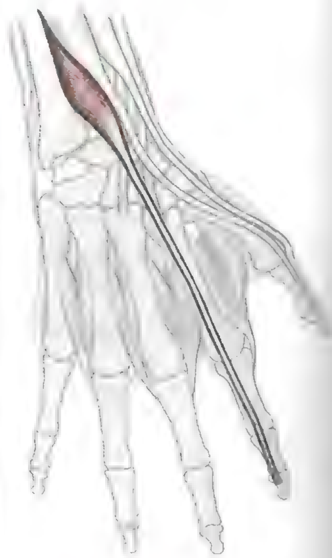
04. Abductor pollicis longus



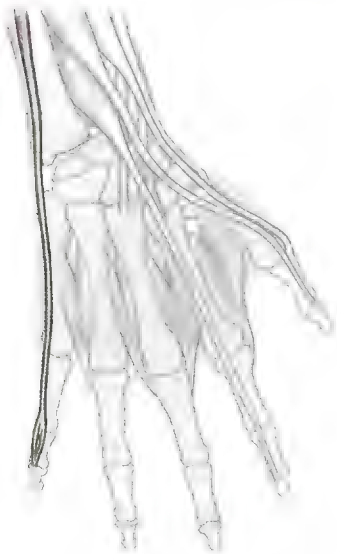
05. Extensor pollicis brevis



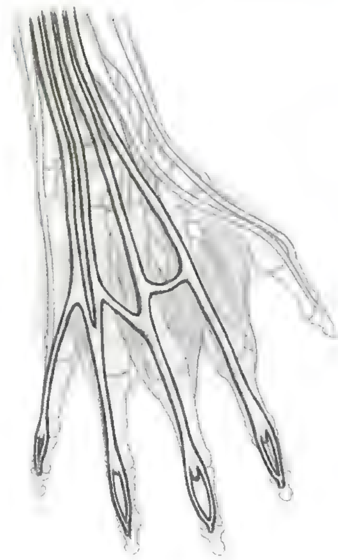
06. Extensor pollicis longus



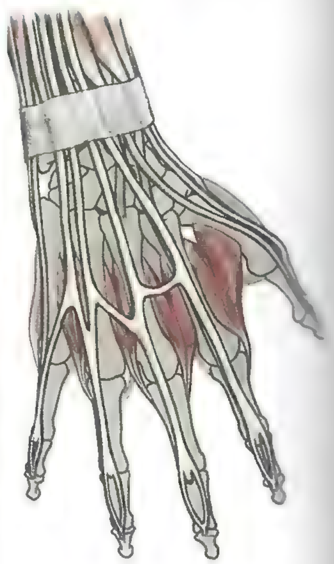
07. Extensor indicis



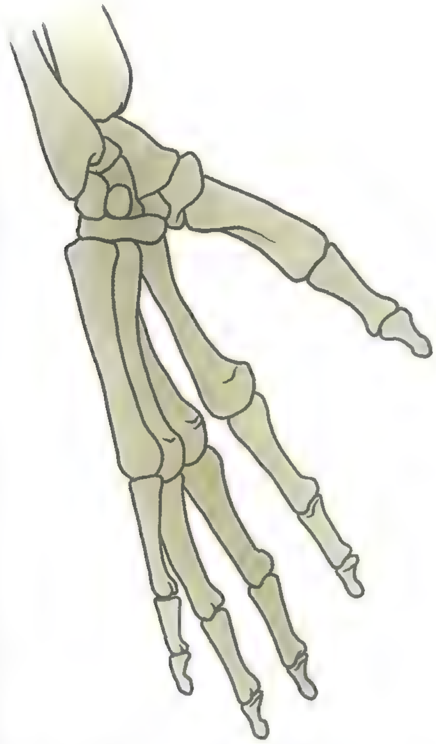
08. Extensor digiti minimi



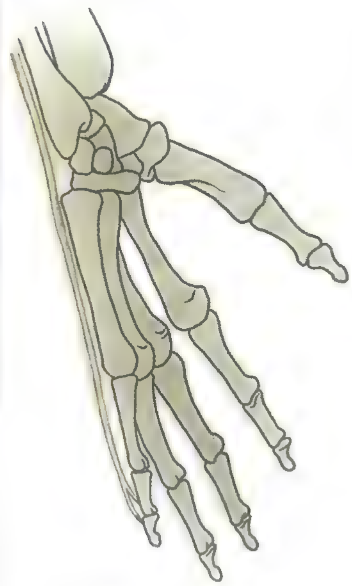
09. Extensor digitorum



10. Extensor retinaculum/ dorsum complete



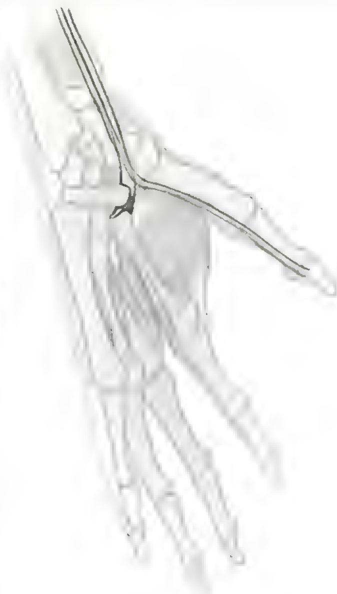
❸ Bones of hand



01. Extensor digitorum

02. Extensor digiti minimi/
dorsal interosseus

03. Pronator quadratus,
dorsal/palmar interosseus

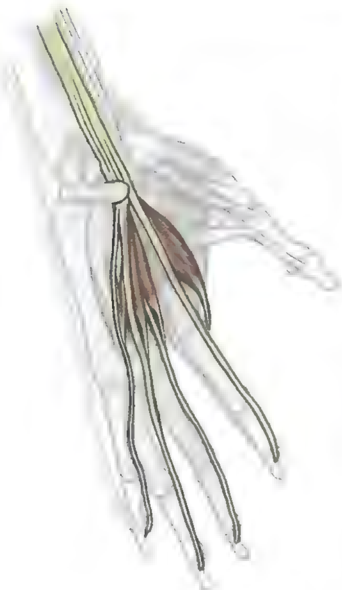


04. Flexor carpi radialis/
flexor pollicis longus

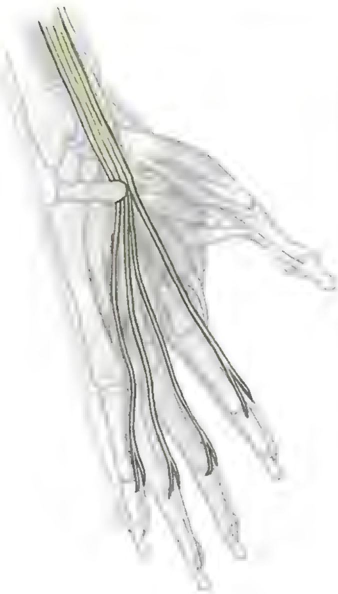
05. Flexor hallucis brevis

06. Opponens pollicis

07. Adductor pollicis



08. Flexor digitorum profundus/lumbrical

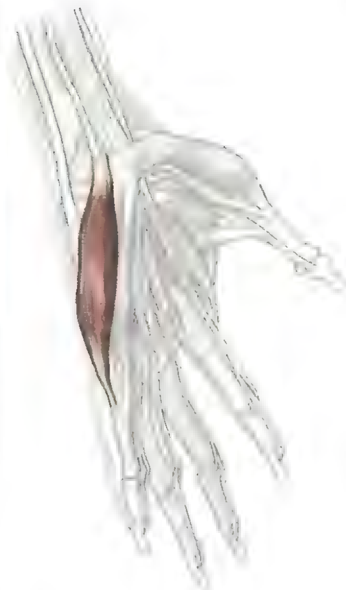


09. Flexor digitorum superficialis

10. Extensor carpi ulnaris/ flexor carpi ulnaris

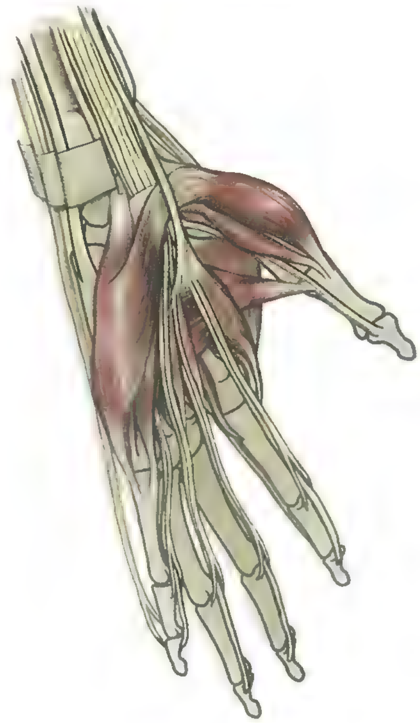
11. Flexor digiti minimi brevis, abductor pollicis brevis

12. Opponens digiti minimi

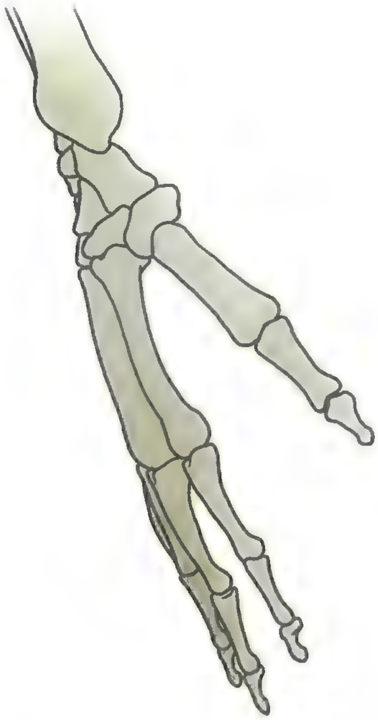


13. Abductor digiti minimi

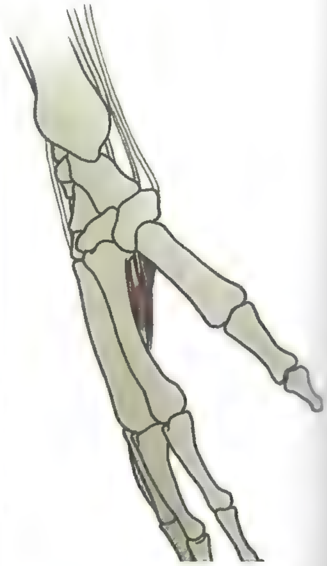
14. Palmaris brevis/extensor retinaculum/palmaris longus



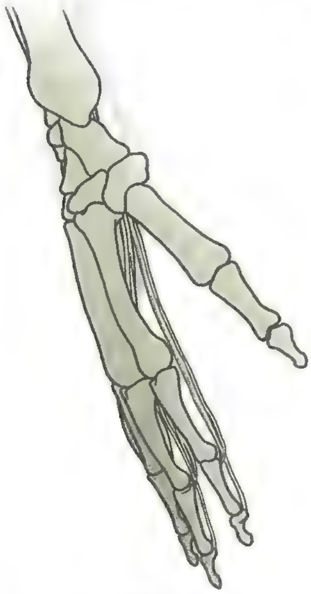
15. Inner palm complete



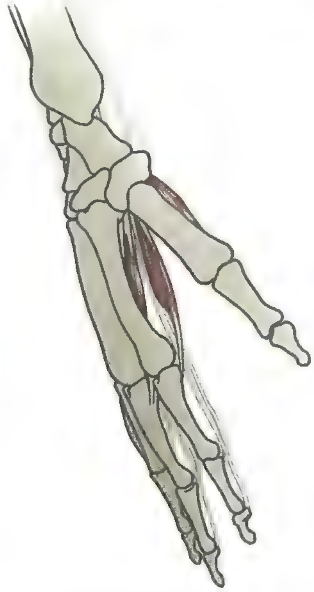
❹ Bones of hand



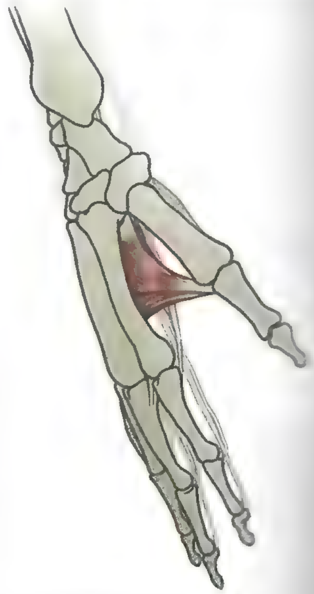
01. Extensor digiti minimi/extensor carpi radialis brevis/ flexor carpi radialis/palmaris longus/ flexor digiti minimi brevis muscle



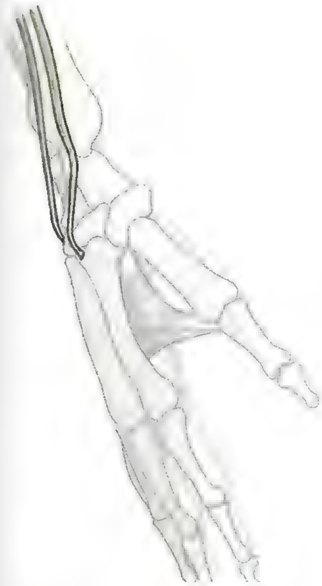
02. Flexor digitorum profundus/ flexor digitorum superficialis



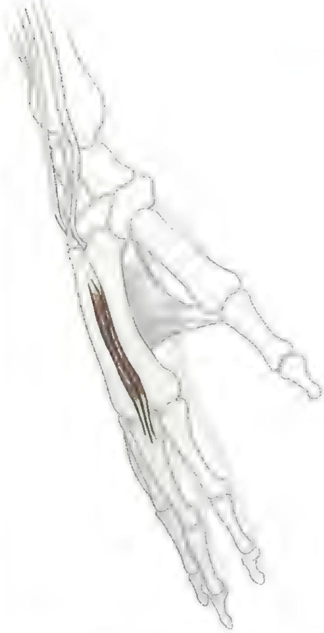
03. Lumbrical/abductor hallucis



04. Adductor pollicis

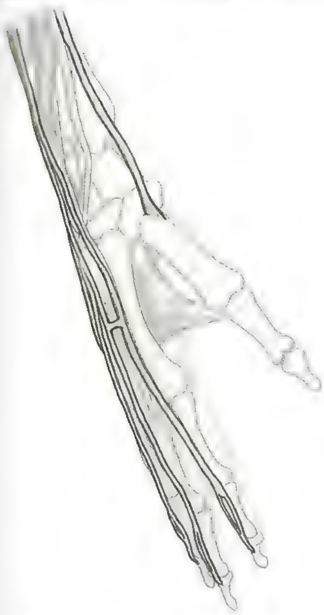


05. Extensor carpi radialis brevis/extensor carpi radialis longus

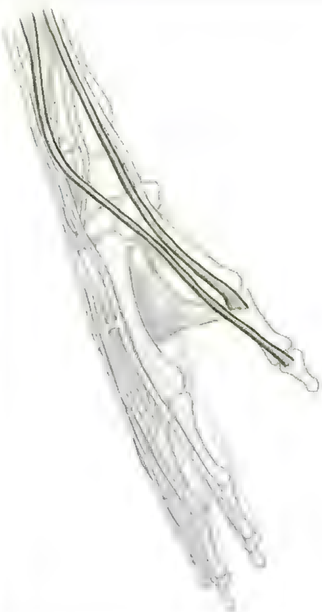


06. Dorsal interosseus

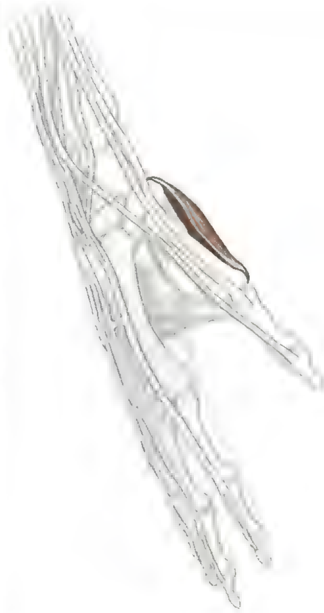
07. Extensor indicis



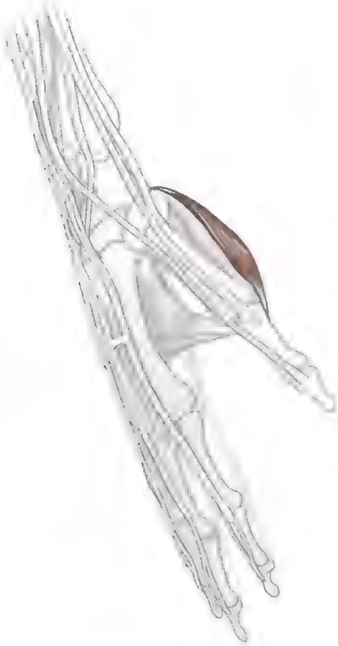
08. Extensor digitorum/ abductor pollicis longus



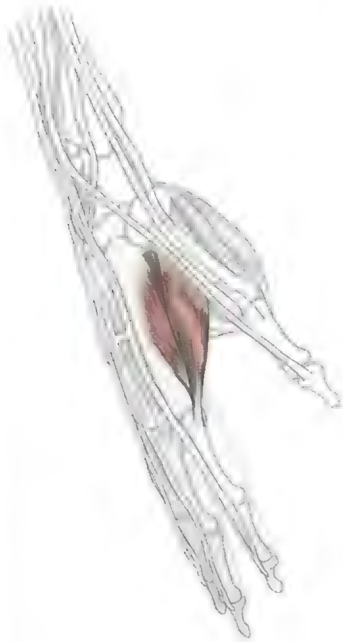
09. Extensor pollicis longus/ extensor pollicis brevis



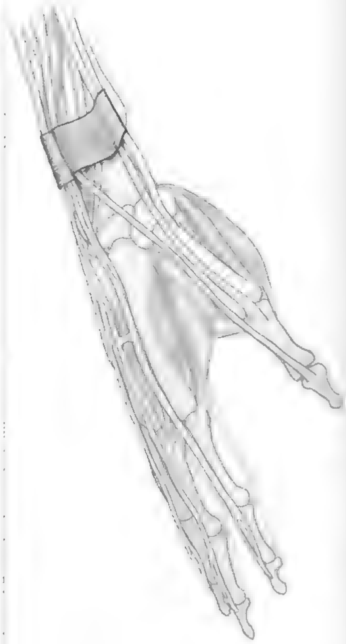
10. Opponens pollicis



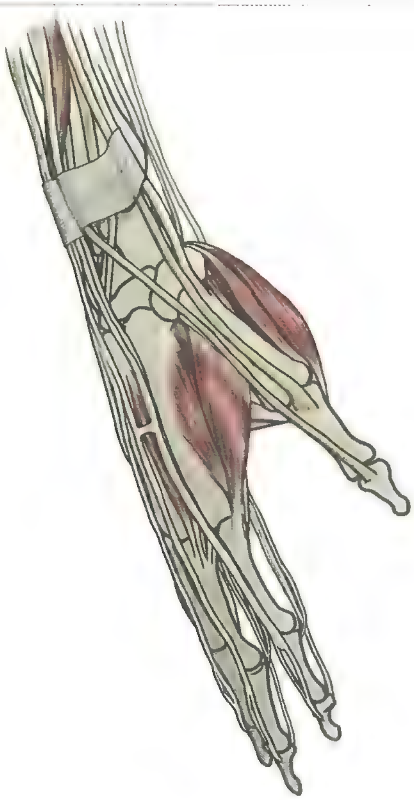
11. Abductor pollicis brevis



12. Dorsal interosseus



13. Extensor retinaculum



14. Thumb-side
dorsum complete

VI
Leg, Foot

The Pinnacle of Engineering

With all the gravity, pressure, and friction that we deal with on earth, it is very difficult to move freely using only our head and spine. That is why we use a special means of mobility that's dedicated to movement.

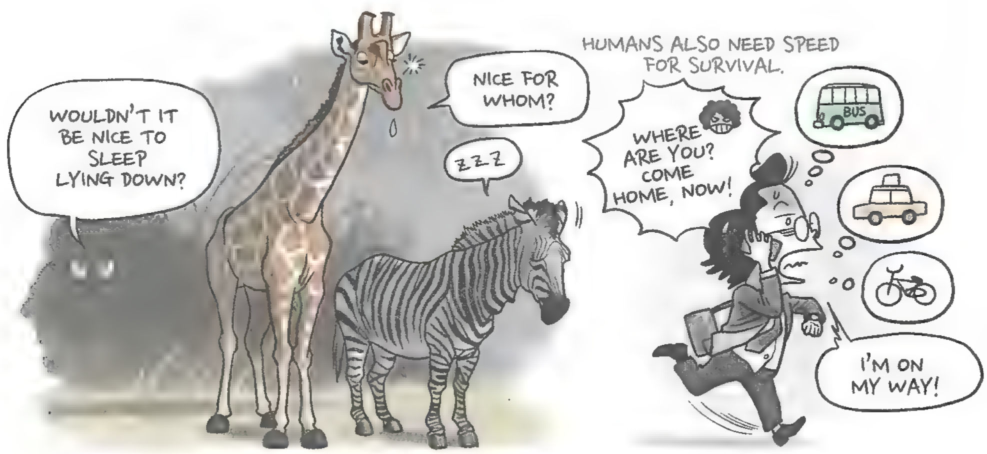
Let's take a look at what role arms and legs play in survival, how they are designed to carry out that role, and how they compare to other vertebrates.

Stepping with the Branch

■Survival - A Matter of Movement

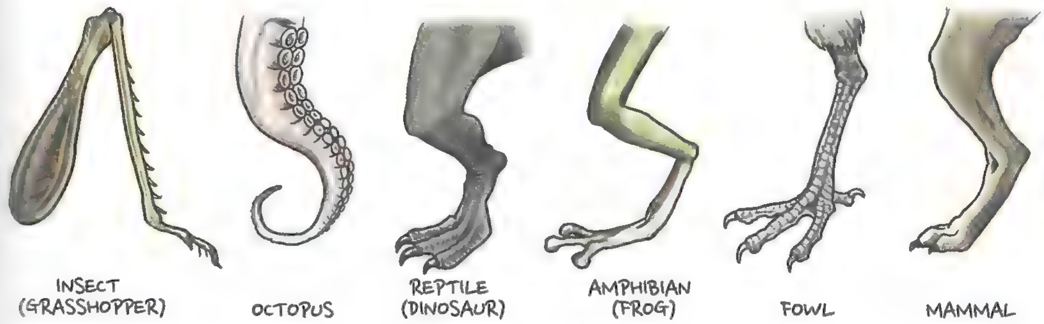
We have already discussed how all living things share a desire to survive, and move accordingly. The most important movement is the ability to change position from one point to another, or moving.

Moving is even more directly related to survival for terrestrial animals; they must deal with gravity, friction, and severe changes in temperature on the ground. Avoiding complicated details; prey and predator have to be constantly on the move as long as food doesn't stay still. It is indeed a very tiring fate.

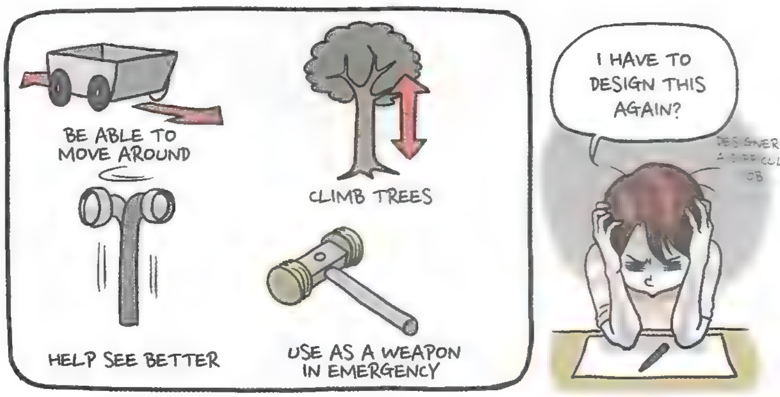


Due to these circumstances, it's natural that all living things on land would want a more efficient, faster way to move safely from one place to another. Animals have continuously improved the means of moving to protect themselves over the hundreds of years of this endless experiment of eating and getting eaten. It is no exaggeration to say that this was one big worldwide project.

Since the beginning of this project, there has been a wide range of input. Some were unbelievably brilliant, while some were less impressive. But regardless of how they were received, one thing that remains true is the fact that they were all means of mobility.



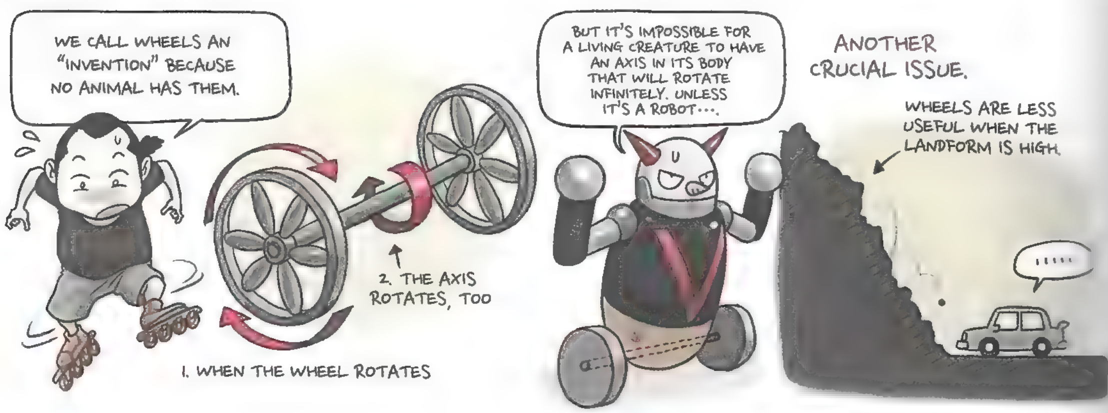
The species that needed the most from this project were vertebrate mammals, Unless in a group, humans are very weak individually and likely to get eaten.



We already know the final output of the design (albeit the project is still ongoing). However, since we are trying to better understand the principles behind it, let's pretend that we don't know what it is and imagine a means of mobility to help the head and body move.

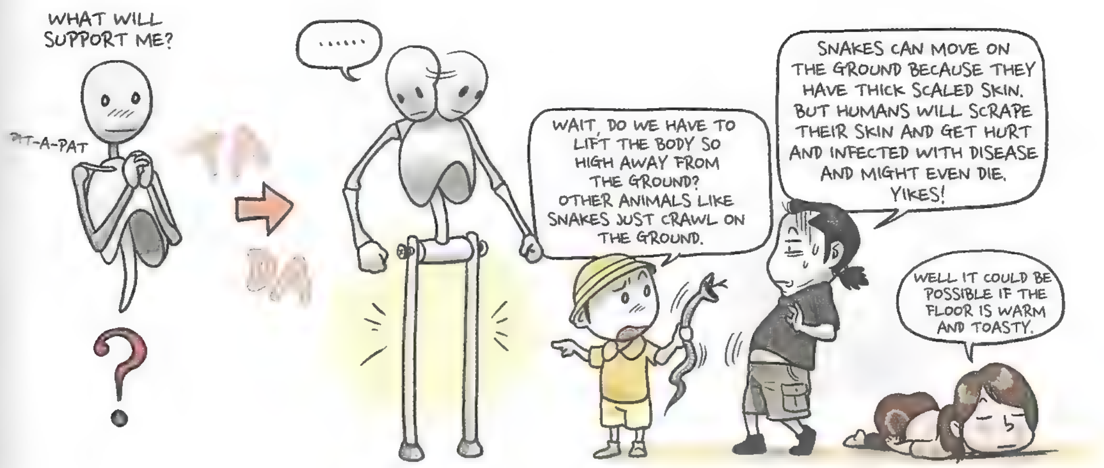
■Designing the Leg

When we think of mobility, the first thing that comes to mind is the wheel. Although the wheel is only one of humanity's greatest inventions, it isn't the most efficient thing to attach to living things. Why?

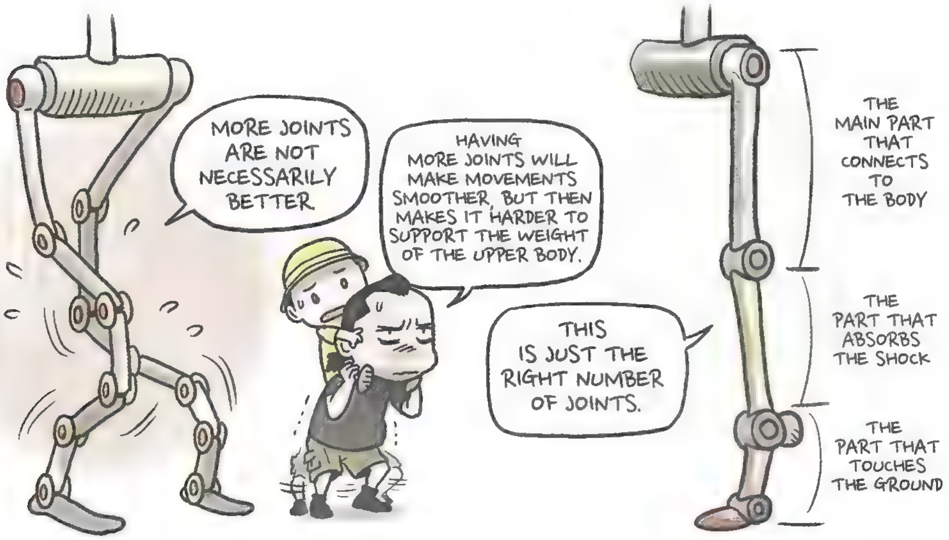


So, it's technically not impossible to attach wheels to living creatures. But it's inefficient to do so because the parts of the body that touches the axis will be worn and damaged every time the wheel rotates.

So without the wheel, this is the only way.

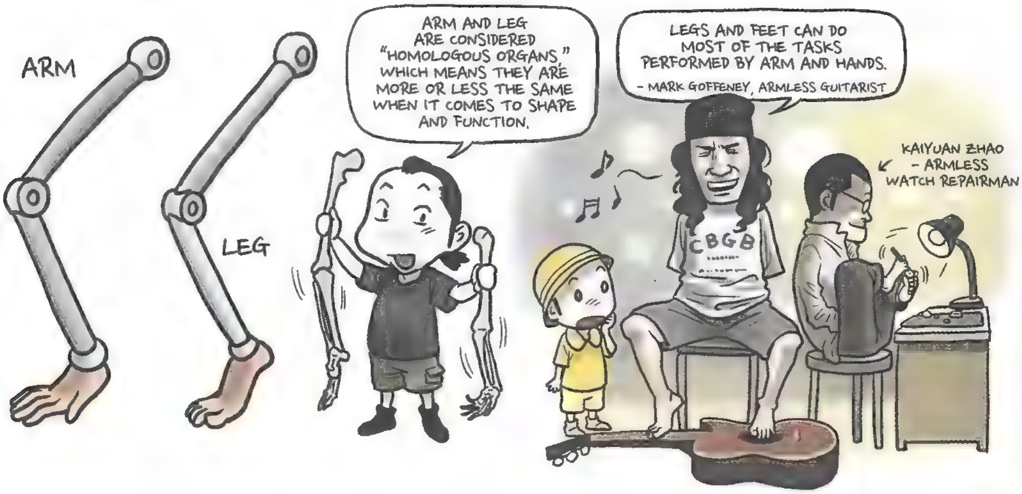


Attaching long legs to a being is simple, but it also needs to be mobile. So, is this enough? If you have ever had to walk in a cast, then you will know how uncomfortable it is to walk with stiff legs. Also, the shock from the ground's surface will be sent directly to the body, so there is definitely a need to make some improvements. That's why we need to divide joints. But…



One may think more joints is better for natural movement. But, having more joints means more weight and structural burden on the joints. Although, fewer joints will make the movement less natural. That's why three joints are the right number, as seen in the diagram above.

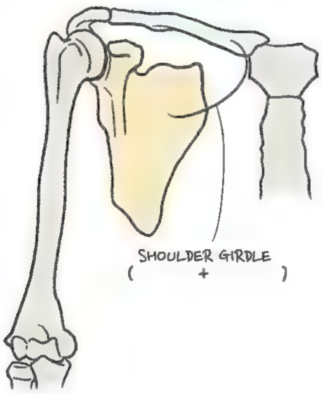
Finally, we have ourselves a quite decent means of mobility. We call it "leg."But, looking at the divided joints, doesn't this shape look familiar? It's very similar to the arm. Recall that a human a
was once also considered a means of mobility in the past.
The two limbs share many similarities, both in terms of function and shape.



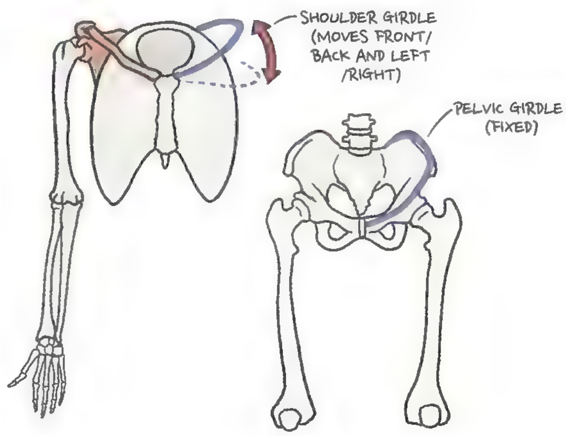
It is a little bit hard to grasp the fact that arms and legs have the same function, but they are no the same. The arm is a modified limb with mobility and other functionalities, whereas the leg is a limb dedicated to mobility. As such, it is not only bigger in bone and muscle but also stronger.

The fact that legs and arms are structurally similar is definitely good news for students studying anatomy. Having a good understanding of the arm will make it much easier to learn about the leg. So, before we start to study the bones of the legs, we recommend flipping back to the early section and reviewing the arm. Comparisons between leg and arm are unavoidable!

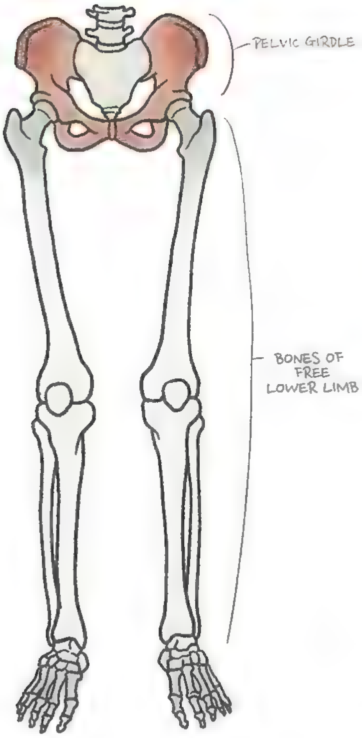
■Pelvic Girdle

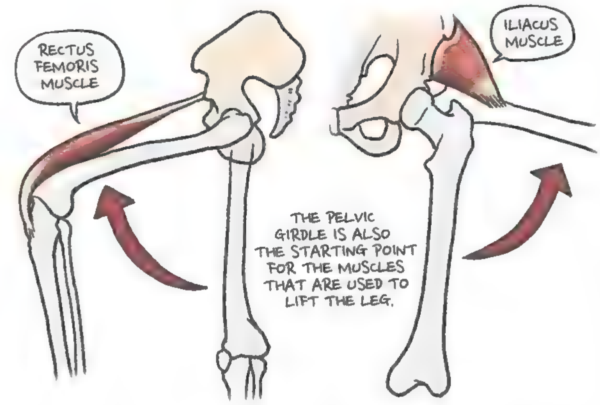


Before we look at the bones of legs, let us recall the shoulder girdle (page 292).
One can imagine all the potential risks and discomfort that may result from directly joining the arm, which moves a lot, to the thoracic cage that protects the heart and lung. That is why we need the shoulder girdle, a separate structure that combines the scapula and clavicle, and that connects the arms to the body.



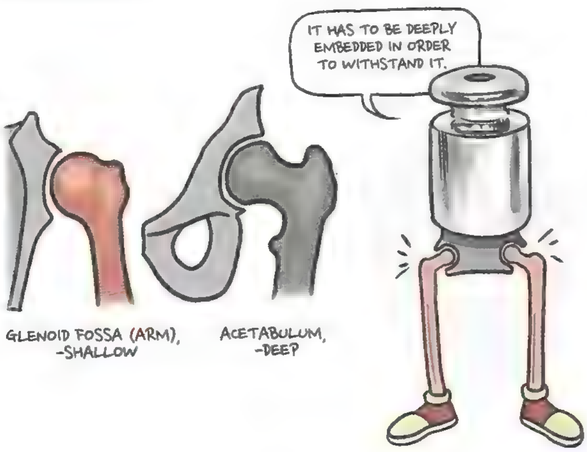
Similarly, the leg also moves a lot and can have a direct impact on the body. So, there needs to be a structure that safely links the leg to the body–the pelvic girdle. Fortunately, we have already learned about the pelvic girdle, the ilium of the pelvis.





The pelvis plays the important role of holding the leg, but because humans stand upright. It also holds internal organs. the pelvis tends to be underappreciated and just considered an extension of the leg. One thing to note is that the sacrum is not a part of the pelvic girdle.

In the case of the scapula that holds the humerus, since the humerus must move freely, the fossa where the humeral head is inserted is shallow (glenoid fossa)
But in the case of the leg, the foremost priority is to bear the weight of the body, not movement, so the fossa where the head of femur is inserted is much deeper.
This fossa is called the acetabulum.

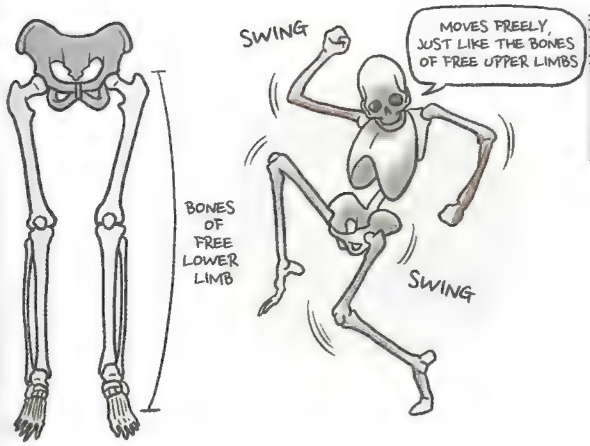


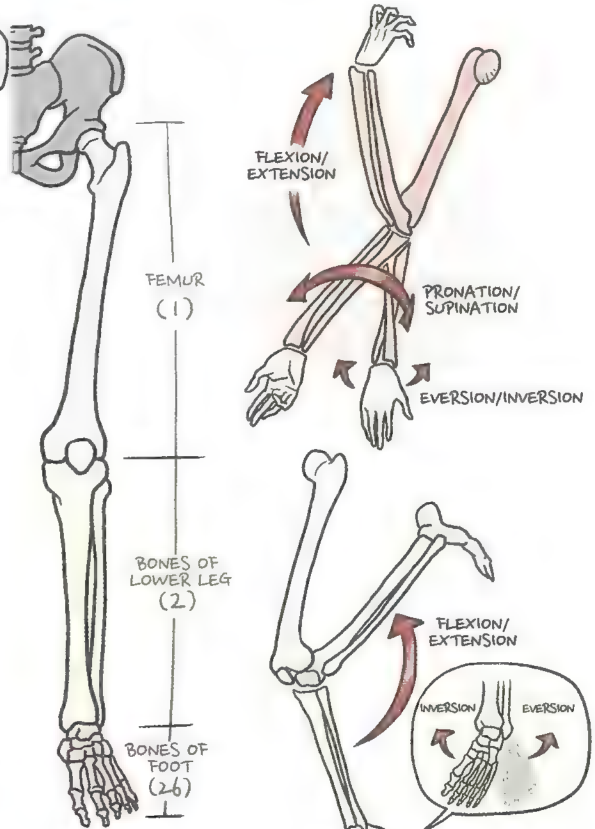
Since we already investigated the pelvic girdle, or the pelvis, in the previous section, we won't go much deeper into this topic and move on to the next topic.

■Bones of free Lower Limb

In anatomy, 'leg' refers to the area from the pelvic girdle all the way down to the toe.

In other words, it not only refers to what we normally consider to be the leg, but also includes the pelvis (the hip). So, legs are much longer than we think.





The part of the leg that excludes the ilium is referred to as the bones of the free lower limb. Unlike the ilium. which is fixed, the bones of the free lower limb can move freely, as the name suggests.

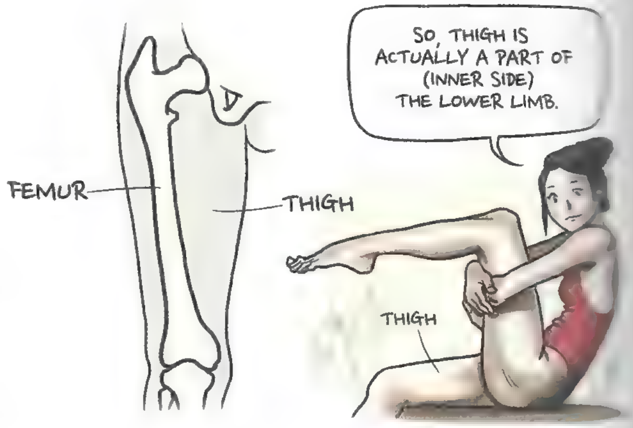
The bones of the free lower limb comprise 1. Femur (1), 2. Bones of lower leg (2), and 3. Bones of foot (26). The bones of lower limb are limited to flexion/extension and a little bit of exstrophia (ankle), so the movement is rather simple. This contrasts with the structurally similar bones of upper limb that are capable of pronation/supination, and the forearm bones that are capable of flexion/extension as well.

Once again, bones of the upper and lower limbs have many similarities, but the lower limb bones have a simpler in structure. But don't't' let your guard down! Legs are important pillars holding up the body. Let's now look at the different parts of the bones of free lower limbs.

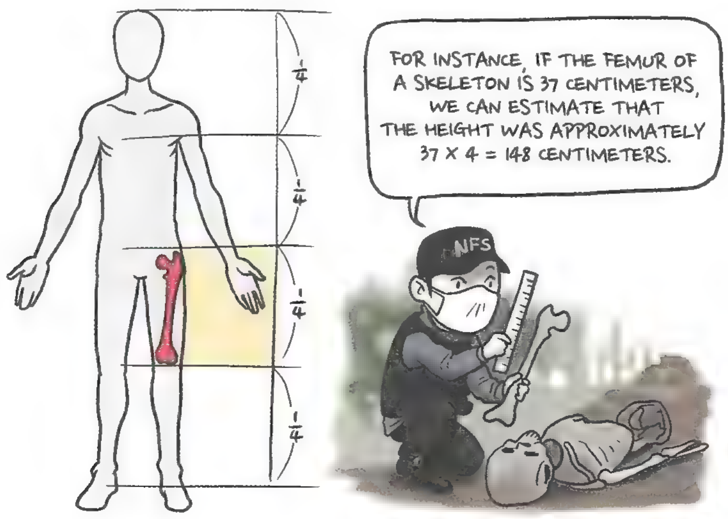
■Thigh, or Femur

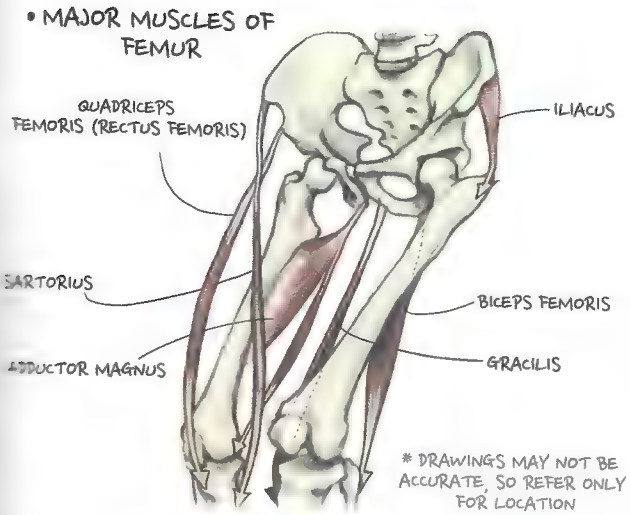
The femur is the top part of the bones of free lower limb, equivalent to the humerus in the arm.

The flesh covering this bone has a wide layer of fat that is visible, so it was once referred to as "big leg" in Chinese characters. This whole section is referred to as 'thigh.' However, when we say 'thigh', we commonly refer to the inner side of upper part of the lower limb where there is a thick layer of flesh.



The femur is the biggest and longest bone in the body. It measures to about 45 centimeters in an adult male, taking up about a quarter of the height. That's why the length of femur is often used to predict the height of a person when remains are uncovered.





The femur must be big because it has to hold on to big muscles (refer to the diagram on the left) that are used to lift the leg or to push back when moving forward.

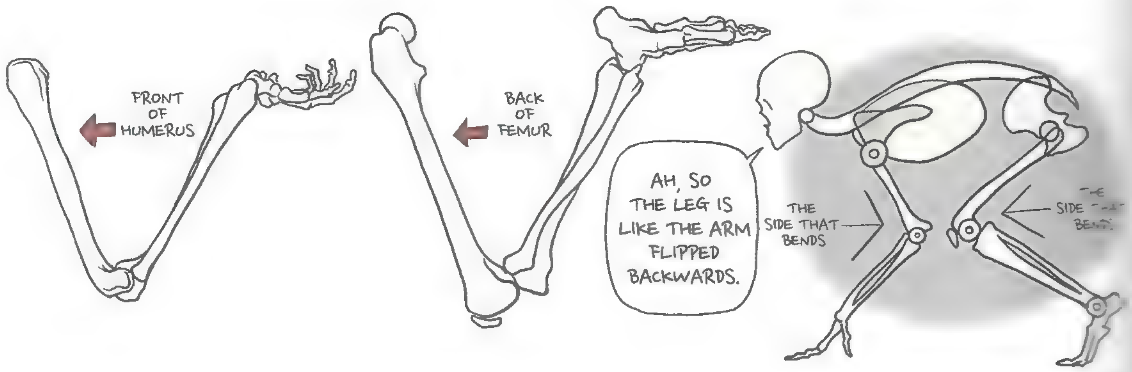
It is an axis that can move the entire body, so it must be bigger and stronger than any other part of the body. It can support up to 30 times the adult male body weight.

The femur is the strongest, biggest bone in the body. It's one of the most well-known bones in the body, and was historically used as a primitive weapon. In other words,t In other words, the image of femur is what pops up in our mind when we think of bones.

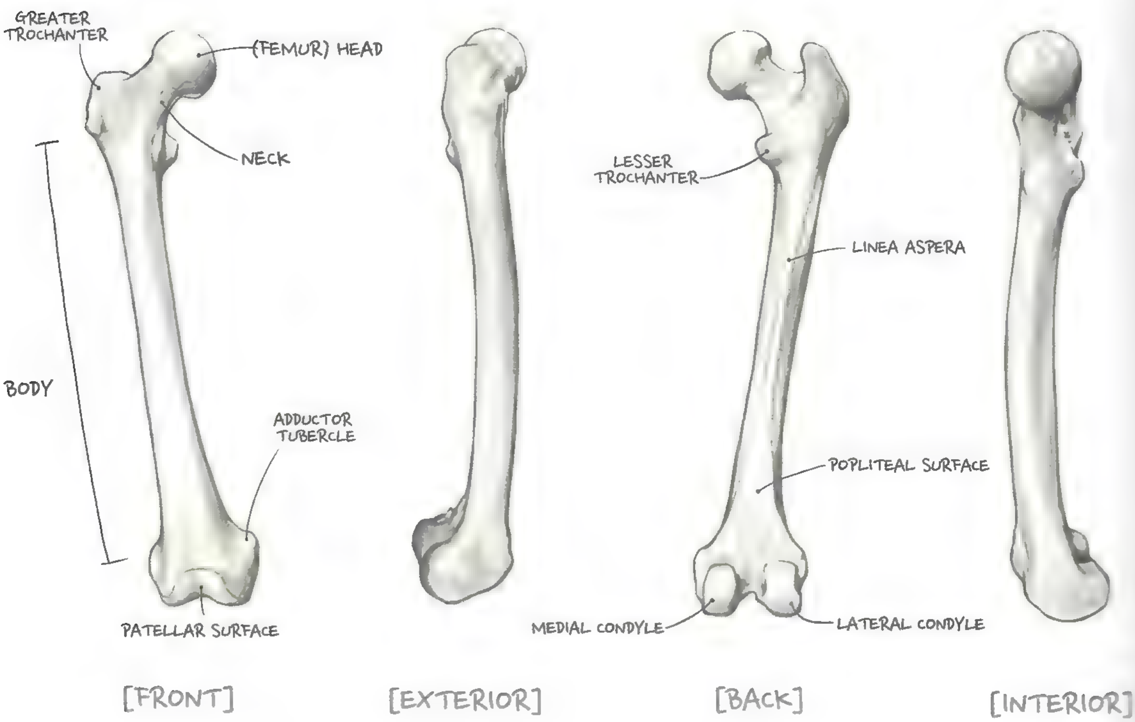
It may look big and unsophisticated, but there are many stories related to the femur, as there was with the bones of the forearm. We will learn about the different parts of the femur before we get to the stories.

❶ Parts of Femur

So now, let's look at the various parts of femur. As we have already mentioned, the femur is very similar to the humerus in terms of function, appearance, as well as role. So, we will compare it with the humerus to help your understanding.



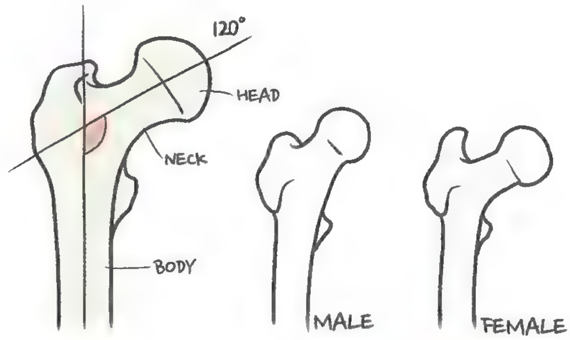
Bones of the upper and lower limbs are similar in shape and function, but the front of the humerus is equivalent to the back of the femur. So keep in mind that the arm and leg have to be looked at from opposite directions.



*Shape of the right side bone

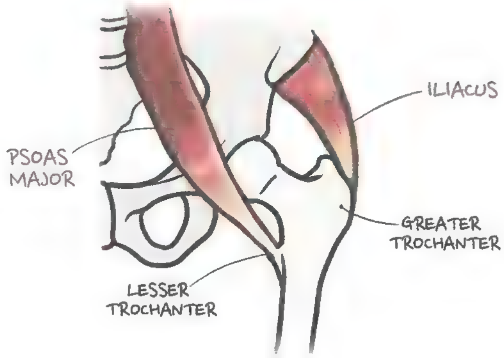
❶ **Head of femur:** this is the part that comprises the acetabular fossa of the pelvic ilium and the hip joint. It is the most freely moving part of the bones of free lower limbs because it is a sphere-shaped cotyloid joint. However, it is restricted in comparison to its homologous organ, the arm.

❷ **Neck of femur:** the part that connects the head and body of femur. It is tilted about 120-130 degrees laterally against the body, and the tilt is greater in women than men. See the below diagram for details.

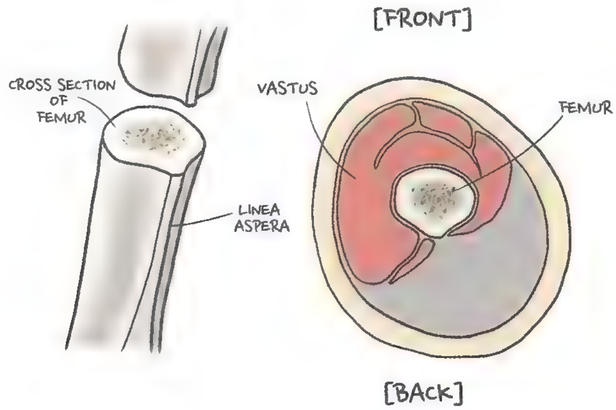


❸ **Greater trochanter:** the part that is protruding on the exterior of the neck. It touches the gluteus medius and gluteus minimus, which make the legs spread out. (page 498)

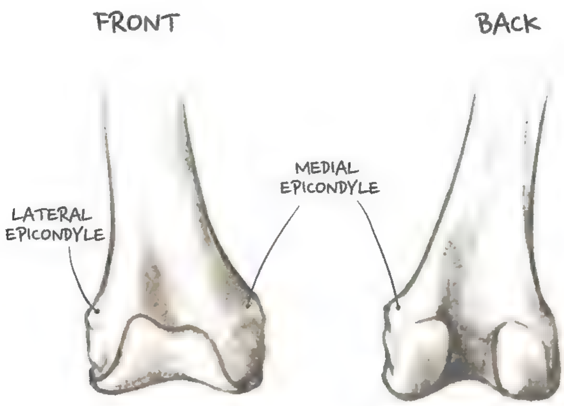
❹ **Lesser trochanter:** the part that is slightly protruding on the interior of the neck. It is the point where the iliopsoas is attached to pull the leg inward. (page 502)



❺ **Body of femur:** the part that takes up the most space in the femur. The cross section is close to cylindrical, and the rugged tuberosity called line an aspera in the back secures the vastus, which helps lift the knee with the body of femur. (page 497)



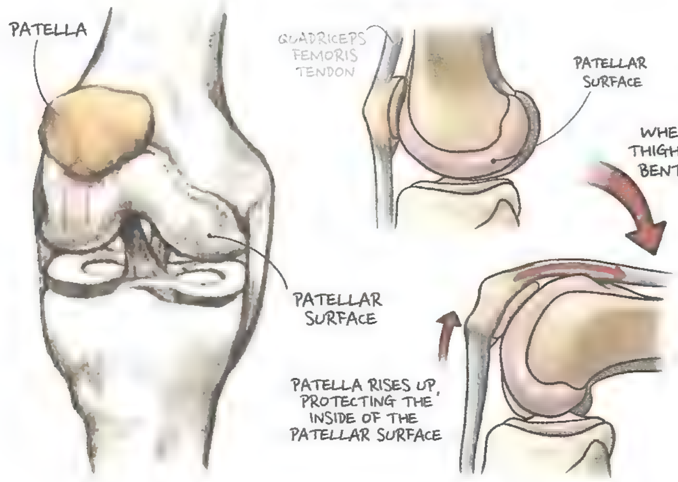
❻ **Lateral/medial epicondyle:** the point where the lateral and medial parts of the linea aspera split on the back of the femur body. The surface between the lateral and medial parts is called popliteal surface.



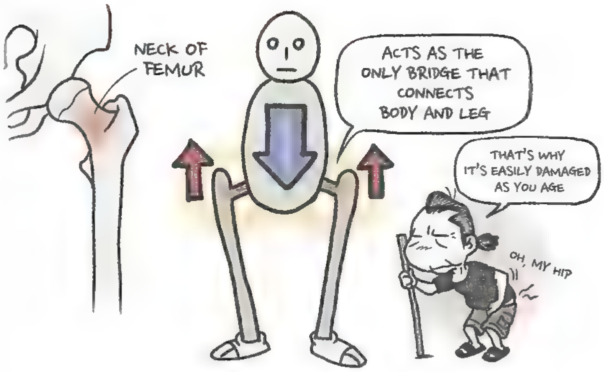
❼ **Adductor tubercle:** a small trochanter located towards the top of the medial epicondyle that touches the tendon of the adductor magnus.

❽ **Lateral/medial condyle:** the round protrusion on both sides of the articular surface at the lower part of the femur and thus is visible on the top of the knee. The backside protrusion is much more apparent than the frontside, and the medial sides tilt down more than the lateral.

❾ **Patellar surface:** the concave articular surface located between the lateral and medial condyle. It is concave because it joins the patella. We will learn more about the patella later.

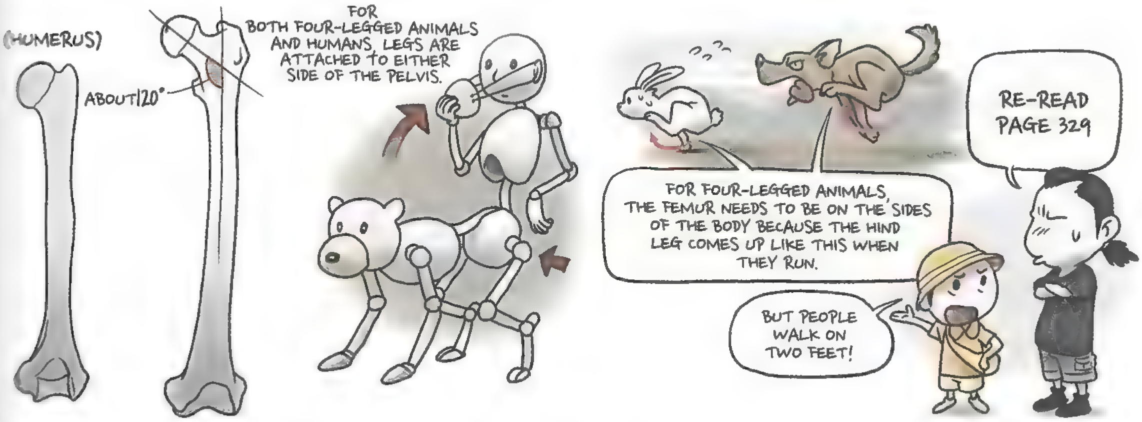


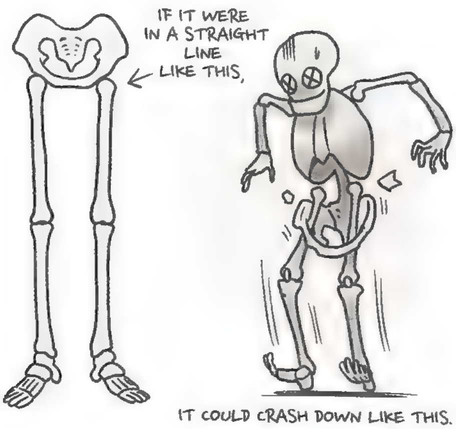
❷ Movement of Femur



The most notable part of the femur is the neck. The neck of the joint the ilium. The joint of the neck is often referred to as the hip joint or coxal articulation.

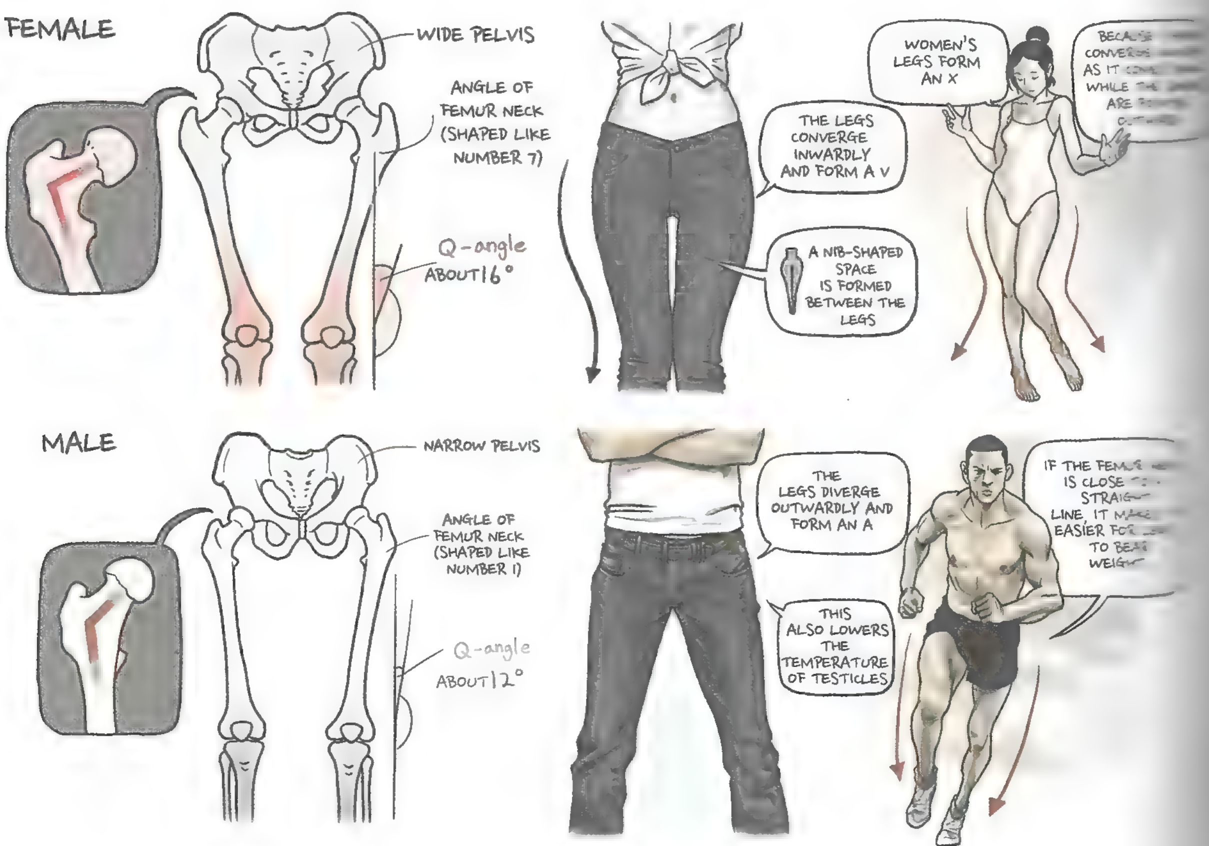
Similar to the head of humerus, the hip joint is bent in an r-shape toward the ilium. As we explained earlier, this is because we need this shape to walk on all fours, as well as to prevent the pelvis from being damaged by all the weight it supports.





The neck of femur is about five centimeters long for an adult, and may vary to some degree but is tilted at approximately 120 degrees on average. So its movement is restricted, just as in the humerus, and the way it overcomes this limitation is also similar to the humerus.

One difference between the male and female pelvis and thoracic cage between genders is the shape of the femur. The femur in men tends to be shorter in the neck and is closer to a straight line, which supports the weight of the big, heavy upper body and makes it easier to run faster.

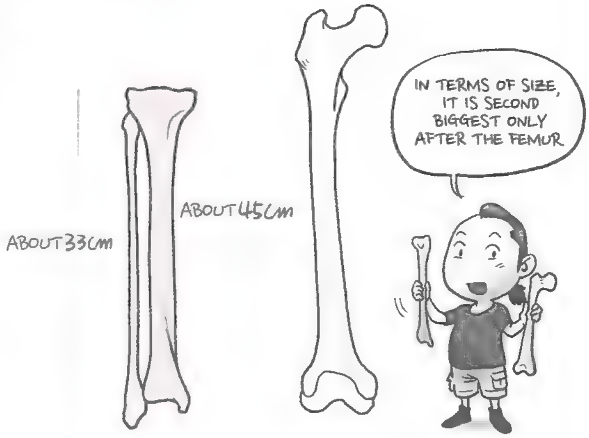


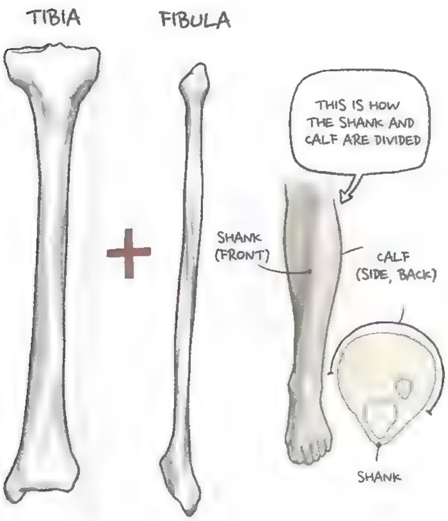
This difference between genders will also have an impact on the angle of the lower leg bone. Men's legs are commonly depicted as having an A shape, while women have a Y shape. Such a mysterious difference between men and women's curves stems from the five centimeter femur neck.

Character concept / painter12 / 2014
Basic postures of female and male characters. The easiest way to add masculinity to females or vice versa is to change the posture of the lower body.

■Bone of Lower Leg, the Shock Absorber

Bones of the lower leg are located between the femur and bones of foot. The length is about three-fourths the length of the femur (about 30-33 centimeters) and supports the entire weight of the human body.

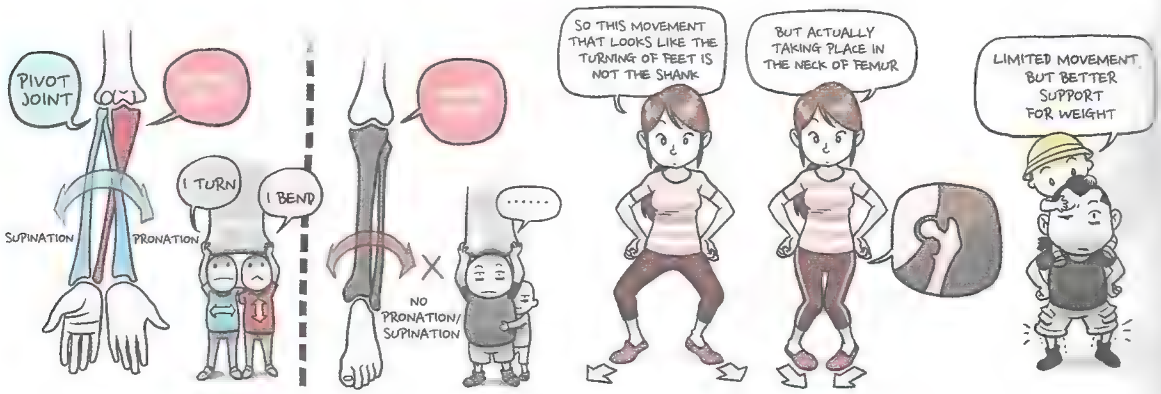




As seen in the diagram, there are two bones in the lower leg, like the forearm:

The tibia, which is the main part of the lower leg, and the fibula, which is the slender bone attached to the tibia.

Since there are two bones each in both the lower leg and the forearm, it's easy to think that their structures are the same. But the bones of the lower leg can only do flexion/extension movements. whereas the bones of the forearm can do flexion/extension and pronation/supination.



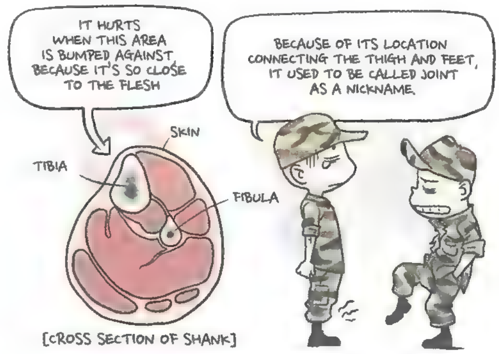
This tiny detail makes a world of difference in terms of what we have to learn. Now that our load has been lightened, let us have an in depth look at the tibia.

❶ Tibia

The big bone on the inner side, out of the two bones of the lower leg. It directly connects to the femur, supports flexion/extension and bears weight. Much of the inside is hollow so that it can bear even heavy loads. Think of how a hollow iron pipe is stronger than a solid steel bar.

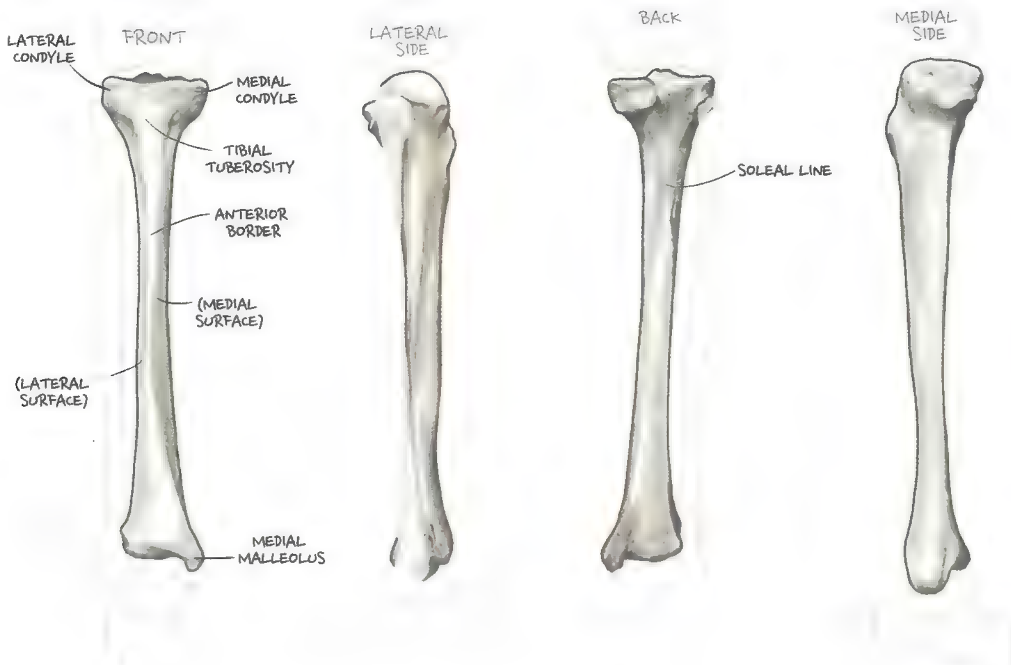
The bone in the arm is also hollow like a tunnel to support weight, just like the tibia. This tunnel-like space is referred to as the marrow space. This space isn't completely empty, but actually filled with small fragments of bones like a loofah.

Tibia was also called the shinbone, with the word shin referring to the shank. The part of the body that we commonly call shank is the front side of the tibia (the front edge), where the bone and flesh are attached. It can absorb any impact with no muscle, making it one of the few places in our body where we can touch the bone.

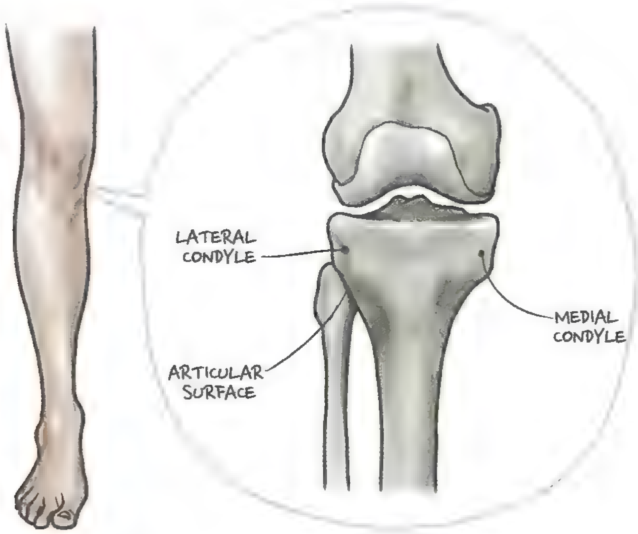


As can be seen in the cross section, the muscles of the lower leg are mostly toward the back rather than the front. This is because it requires much more strength for an animal to lift the heel than the balls of the feet.

The following are some of the main parts of the tibia:

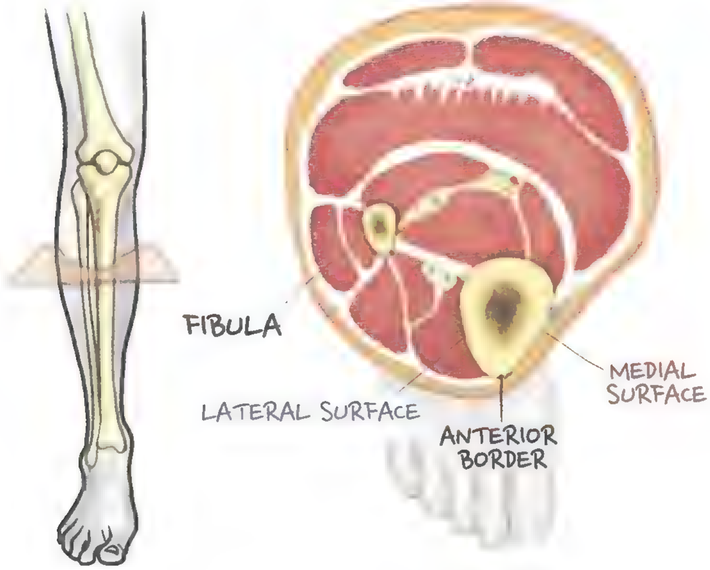


❶ **Lateral/Medial condyle:** This is the surface that joins the lateral/medial condyle to form the knee joint, so it protrudes at the very top of the tibia on both sides. Right below the lateral condyle is the fibular articular surface, which is where the head of fibula is attached.

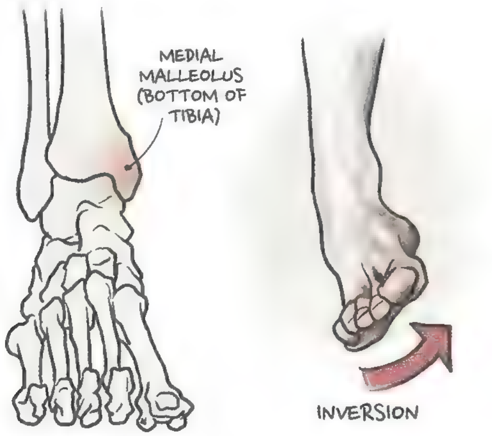


Tuberosity of tibia: The point where the tendon (patellar ligament) from the femur is attached. This is where doctors tap when conducting the knee jerk reflex exam.

Anterior border: The cross section of the body of tibia is shaped like a triangle, and this is the sharpest edge towards the front. This is what divides the medial and lateral sides, and calf muscles are located on the lateral side.



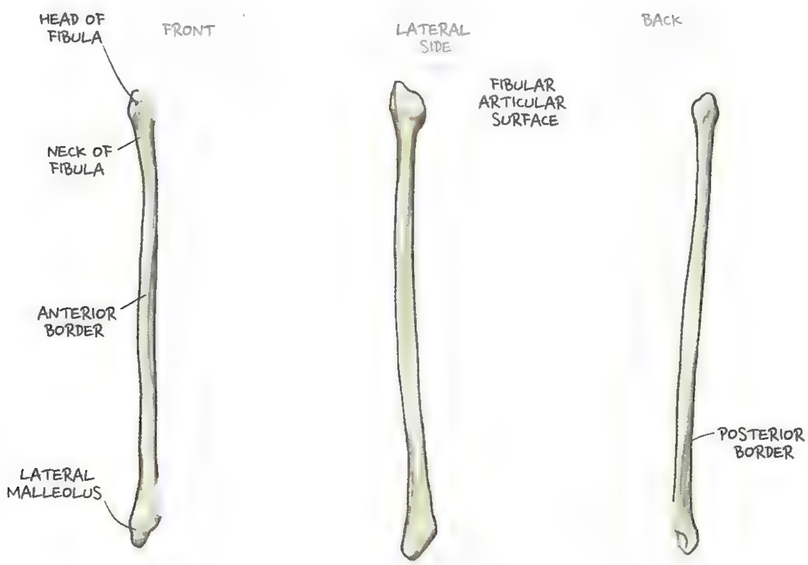
Medial malleolus: Equivalent to the styloid process of the bones of forearm. Located higher than the lateral malleolus of the fibula, so the inversion of the ankle is slightly bigger. The exstrophy of the ankle will be discussed later (page 472).



❷ Fibula

The fibula is dependent on the tibia. It is the equivalent to the ulna of the forearm, but it doesn't play that much of a role other than helping the tibia support weight and holding muscles in place. That's why this bone is vestigial in most animals that don't support weight with their two legs like humans. In other words, the tibia and fibula can be considered one big bone with a little bit of space in between.

The following are some of the main parts of the fibula



❶ **Head of fibula:** The stubby part that connects to the tibia. The part that directly joins with the tibia is called the articular surface of the fibular head.

❷ **Neck of fibula:** The slim part right below the head of fibula. Right below is where the body starts.

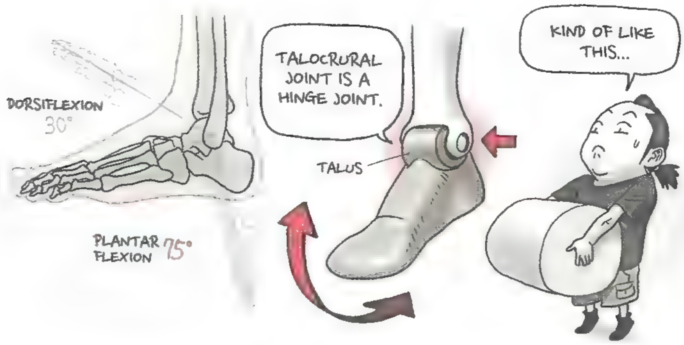
❸ **Anterior border / posterior border:** The protruding line that traverses askew down the body of fibula. This is what divides the lateral and medial sides, and where various muscles like the calf muscle and extensor digitorum start.

❹ **Lateral malleolus:** The protruding part that is equivalent to the styloid process of the forearm, or the exterior malleolus. It is lower than the medial malleolus of the tibia.

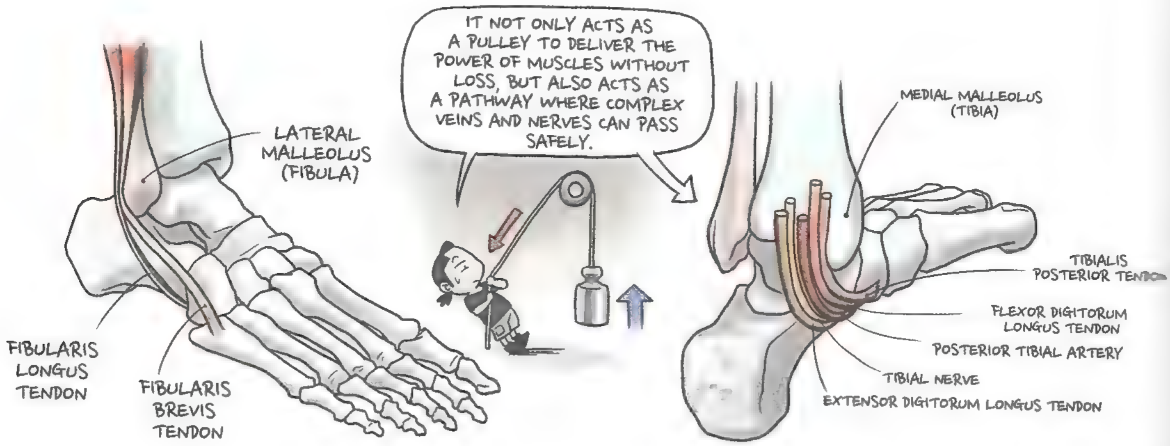
■The Crooked Malleolus

So, we have looked at some of the main parts of the tibia and fibula. We want to bring attention to the lower part of the tibia and fibula that protrudes, the medial and lateral malleolus. This is where we normally refer to as the 'ankle bone.' It almost looks like two peaches sticking out of an otherwise straight leg.

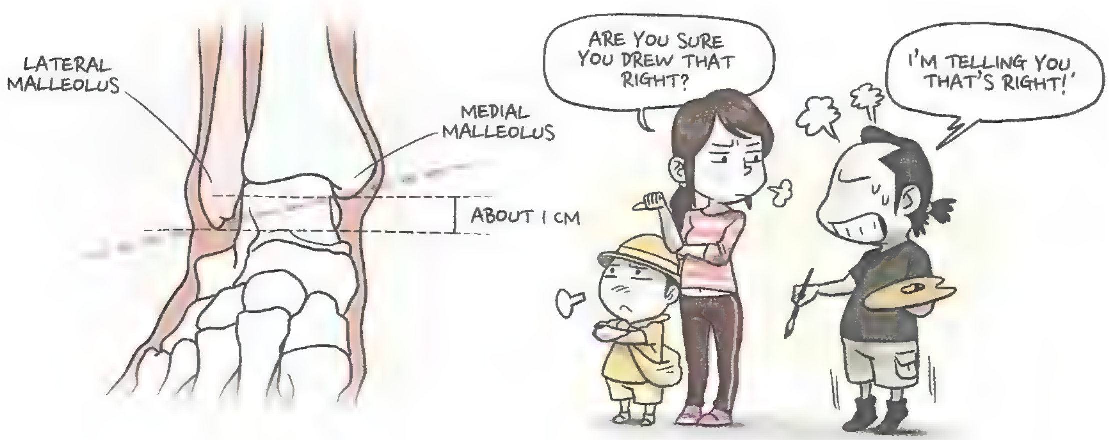
Bones poke out on either side because this is a joint where the bone of the feet (talus) sits in a U shape, as you can see on the diagram. That's how the ankle can make the flexion/extension (plantar flexion/dorsiflexion) motions.



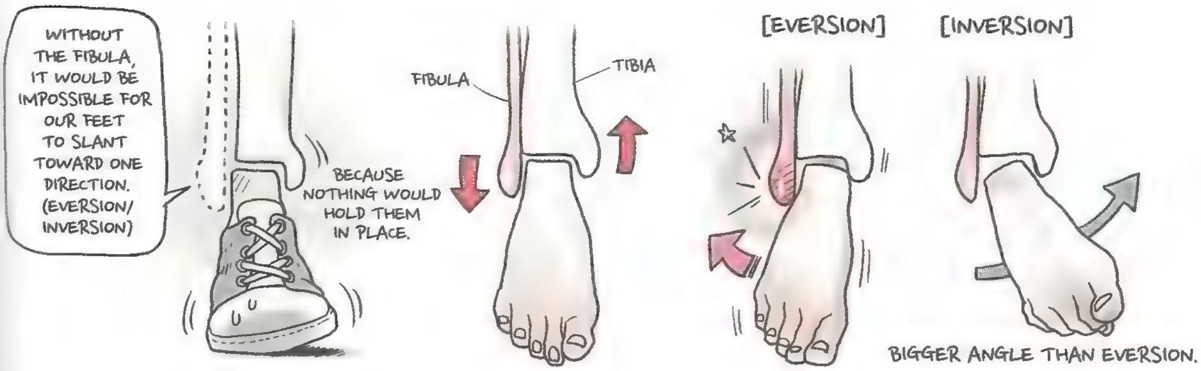
Because the malleolus is protruding outward, the tendons, veins, and nerves can move safely free from external pressure or physical movement.



So far so good. But there is something that might strike us as odd when we take a closer look at the malleoli on both sides.
The medial malleolus (tibia) seems to be about 1 cm higher than the lateral malleolus (fibula), making the malleoli look misaligned.



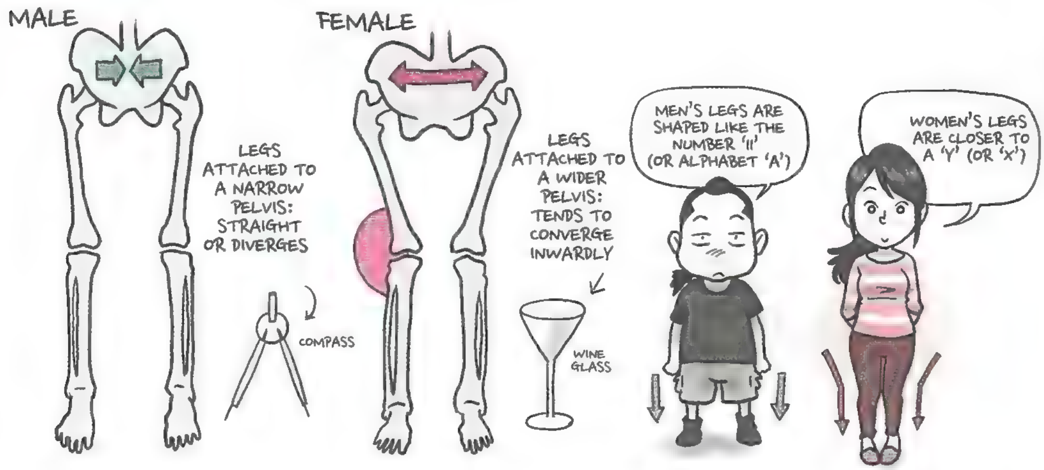
This is related to eversion/inversion of the ankle. Eversion/inversion simply refers to moving the ankle so that the sole of the foot faces either the lateral or medial side. Because the fibula on the lateral side is located lower, inversion takes place more frequently than eversion. This means the ankle bends better inwards (medial side) than outwards (lateral side).



But, eversion/inversion takes place more in the ankle, than inside of the malleolus. So, we'll discuss this more in depth later (page 547). For now, just know that the malleoli look misaligned because of exstrophy.

■The Q-angle of the Leg

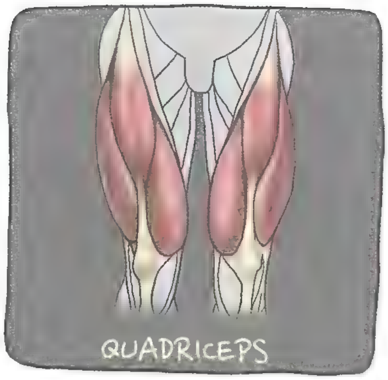
Earlier, we learned about how the size of the pelvis affects the appearance of different genders. The same goes for legs. Men usually have a smaller pelvis and the neck of femur is close to a straight line, whereas women usually have wider pelvis and their neck of femur is angled, thereby impacting the angle between the thigh and lower leg.



Since women have a wider pelvis, the starting point for legs (head of femur) are further apart than mens. The thighs converge inward to achieve balance, thereby creating an angle in women's legs. But wait a minute, this sounds familiar…

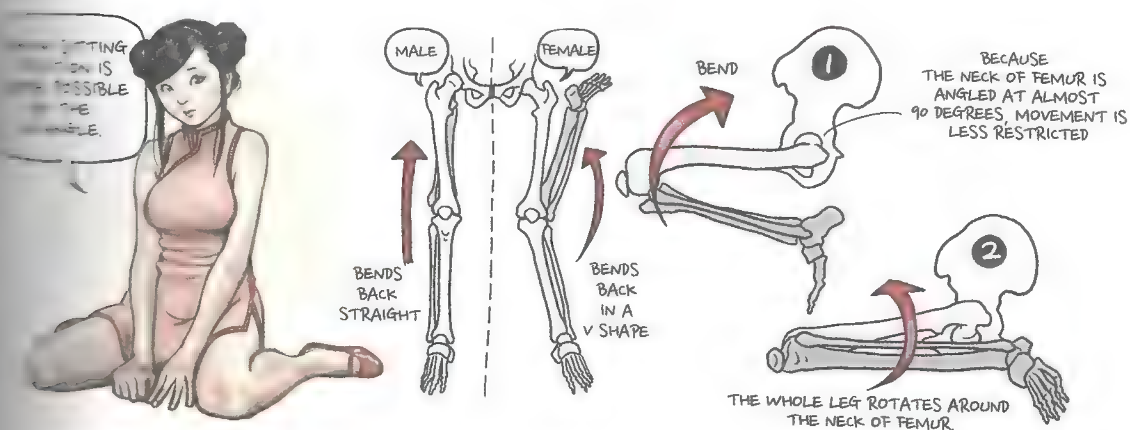
We need a vertical or horizontal line of reference to measure the angle. For the carrying angle, the humerus acts as the line of reference. For legs, the bone of lower leg is the most perpendicular to the ground and thus acts as the line of reference. The angle is about 12 degrees for men, 16 degrees for women.

This angle corresponds to the carrying angle of the arm is called the 'quadriceps (quadriceps femoris) angle,' or 'Q-angle' in short. It's just a fancier way of saying 'thigh angle.' The carrying angle was created because of the wide pelvis, and the Q-angle is also created from the angle between the pelvis and the neck of femur. It seems like the pelvis has an impact on both arm and leg.



Although the arm and leg angles were created because of the same reason, whereas the carrying angle has somewhat of a functional role (easier to carry goods), the Q-angle is pretty much useless. It could even be considered a weakness in terms of athletic movements.

Even though the Q-angle is useless from an athletic point of view, it does have aesthetic advantages. For example, crossing legs could be considered a protective mechanism for females to protect their uterus and the Q-angle locks the legs more securely, adding a subtle feminine appeal. It also makes it possible for women to sit in a W position.



Even though leg crossing and W sitting position are direct results o the Q-angle, we must be cautiou to not generalize or limit it as bein exclusive to women.

There will be men who can do this and there will be some women wh can't. This is just a visual referenc based on anatomical facts, so consider it a nice reference when striking a pose that is flattering to your body or when drawing sketches.

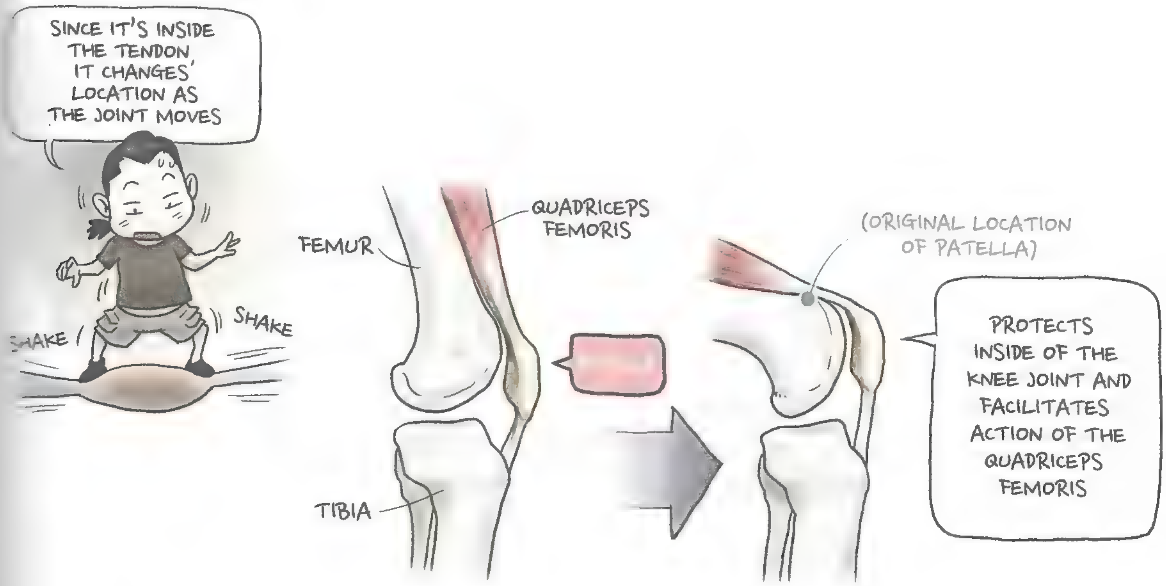
Some may ask what use visual appeal is. It may be true that running faster is more helpful to survival than being visually attractive. But what if we take a more long-term perspective? It may be more important to appeal to the opposite sex and reproduce than to stay inconspicuous to the enemy.

■Between the Knees

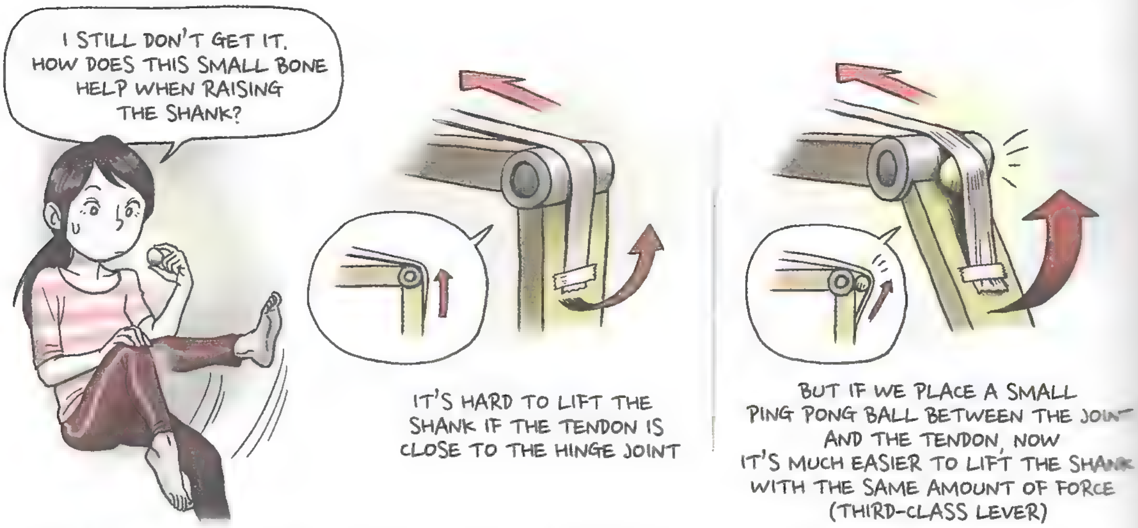
We can't leave out the knee, which is located between the thigh and lower leg. It could seem like an insignificant joint between two bones, but there is a reason than it earned its own name.

The kneecap is also called patella because it looks like a small dish covering the knee. It looks like it's floating because it contains the quadriceps femoris, which connects the tibia and fibula.

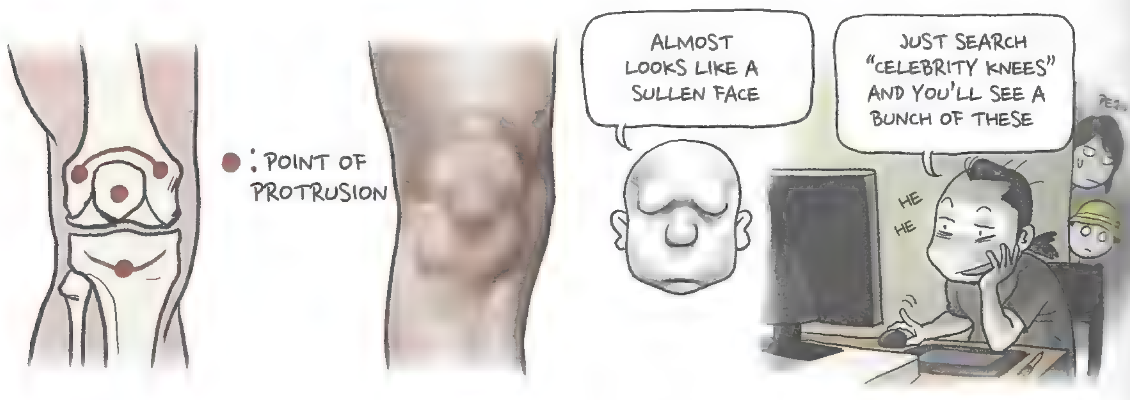
As you can see, the patella not only protects the hollow gap of the joint between the thigh and tibia but also acts as a crucial pulley that facilitates the flexion/extension motions of the femur and bone of lower leg.



Not understanding the pulley concept? The following experiment will help you better understa
the role of the patella.



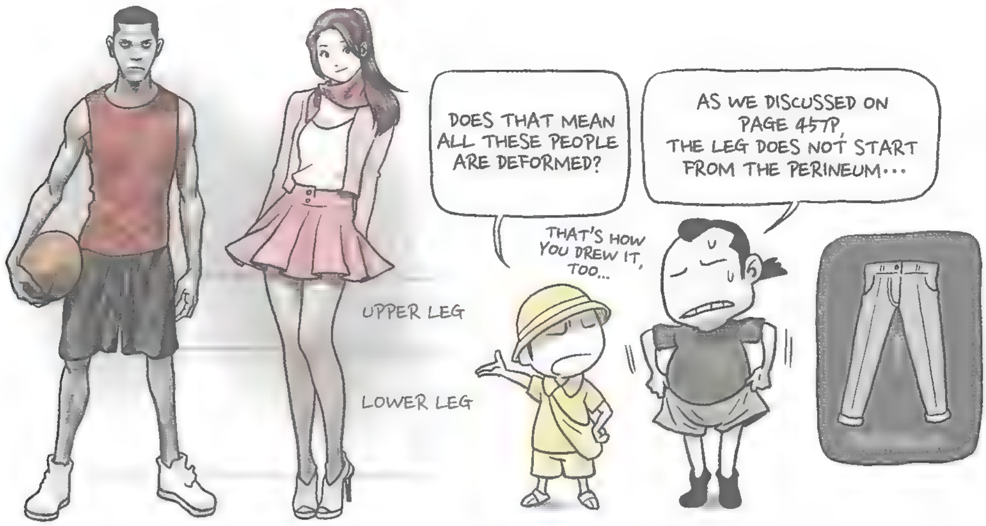
Since the patella is a protruding bone located between the thigh and lower leg, it makes the appearance of the knee quite unique. It's a lot easier to talk about the knee when you understa its structure, so let's take this opportunity to take an interest in knees and start observing them more closely.



For your reference, the sunken parts on both sides of the knee are formed by the 'iliotibial tract' (page 498) inserted into the lateral epicondyle of the tibia and the 'pes anserinus' (page 500) formed by hamstring tendons on the medial side. That is why the knee appears to protrude.

■Proportion of Thigh and Lower Leg

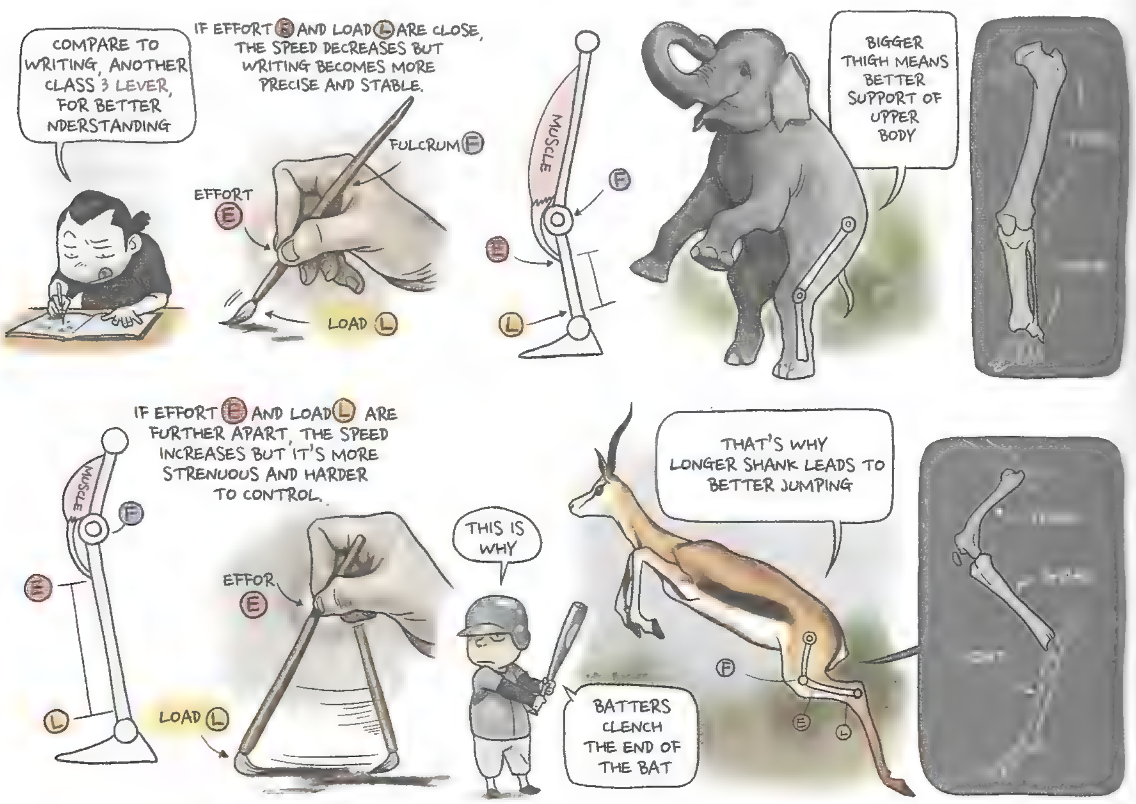
Let's slow down and take a breather.
When I first took art anatomy, I learned the femur is the longest and biggest bone in the body, just as we learned it. But I distinctly remember being very puzzled by this at first. This is because the lower leg looks longer than the thigh a lot of the times.



…as an illusion all along. If we go by what we can see without considering the actual area of …ement, the thigh does look shorter and sometimes clothes deceptively make the thigh look …ter. But despite being anatomically incorrect, we can't help but think that it looks nicer when … lower leg is longer than the thigh. Why is that?

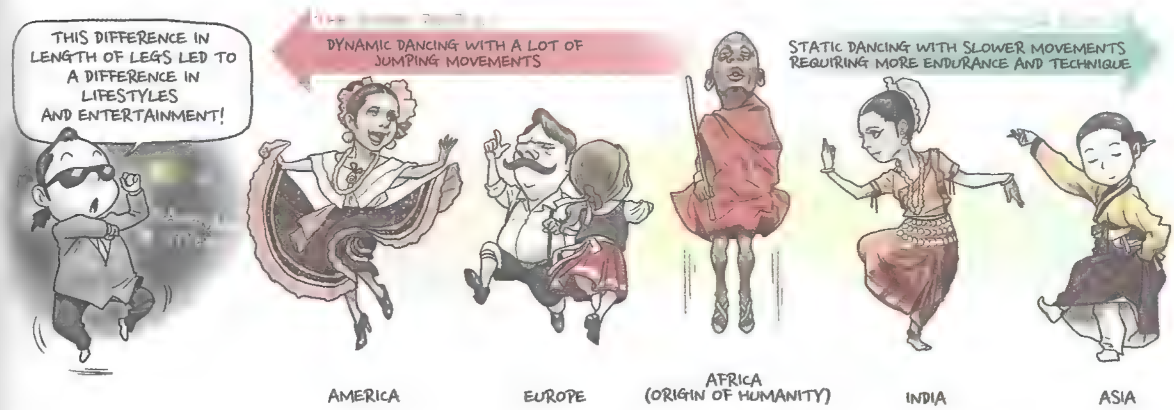
Before we examine why, let us recall a simple scientific principle that we learned in elementary school. Do you remember the principle of leverage? There are three classes of levers.

Legs of humans and four-legged animals are Class 3 levers. Class 3 levers are characterized by the fact that the effort is located between the fulcrum and load, and the distance between effort and load is what determines precision versus speed.



Animals on this earth had to choose between length of thigh (precision, endurance) and shank (speed, agility) based on their environment and survival mechanisms. Humans chose the former of the two because we stand on two feet, the lower half of the body supports the upper half, and hands are used to carry things. But within the humans species as well, different races have evolved slightly differently based on their own needs.
Some tribes had to walk through snow, while some had to run fast across the grassland.

Homo sapiens began migrating out of Africa about 200,000 years ago, and since then tribes in colder regions gained longer thighs while tribes in warmer regions developed longer shanks. This in turn led to the conception of unique cultures, spanning from method of hunting and gathering to lifestyles.



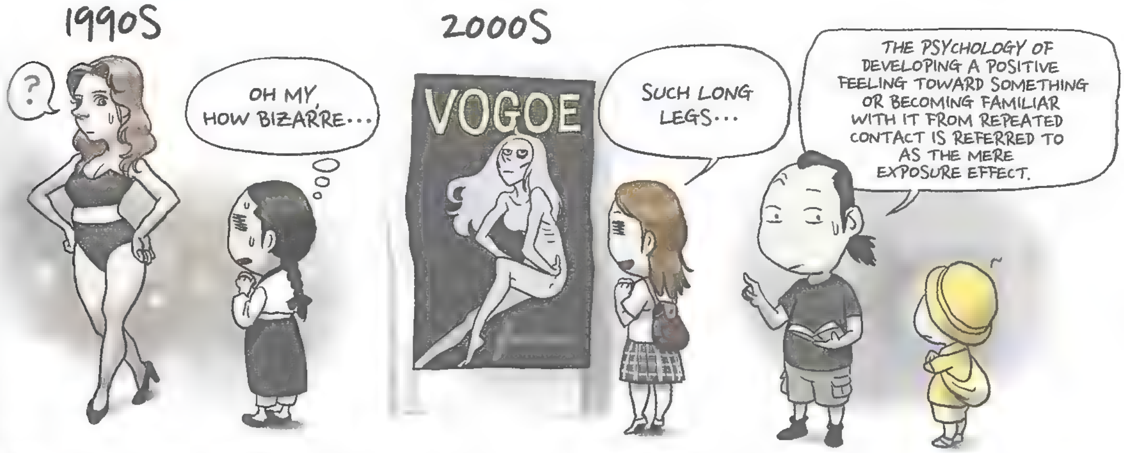
Longer shanks make it easier to jump, therefore this led to more jumping moves in dances like tango and polka. But longer shank also means less control over legs, so this led to a standing culture. On the other hand, longer thigh makes it easier to sit down and get up. This led to the sitting culture and added more endurance elements to dances. For instance, one of the moves in traditional Korean dance involves the dancer sitting down slowly, then getting back up slowly, which is all possible due to longer thighs.

So, the human body can take different shapes based on the environment, but we still tend to have a narrow view of our body, especially when it comes to the standard of beauty. Honestly, why do we think a deer with a long shank is prettier than an elephant with a long thigh?

We say strength is beautiful. It is instinct for animals to want to mimic the appearance of other living things that have a competitive edge in survival. If so, shouldn't humans say that an elephant is more beautiful because it's much bigger and stronger compared to a deer? So how come it's more common for us to be envious of a deer than an elephant?

There are probably a plethora of reasons why we think this way. It is partially because speed is more useful today than strength. However, biggest reason is that most visual forms of media that we are surrounded by, whether it's TV, movie, or the internet, originate from Western cultures, where people have legs closer to herbivores. Just think of the facial features we consider beautiful, and you'll see what I mean.

Just one century ago when Koreans had almost no communication with the West, the face and body shape of Westerners seemed strange to us. But now, no one thinks those features are weird because we are now familiar with the cultures and media that are run by Westerners. Beyond a sense of familiarity, it's now something we look up to.



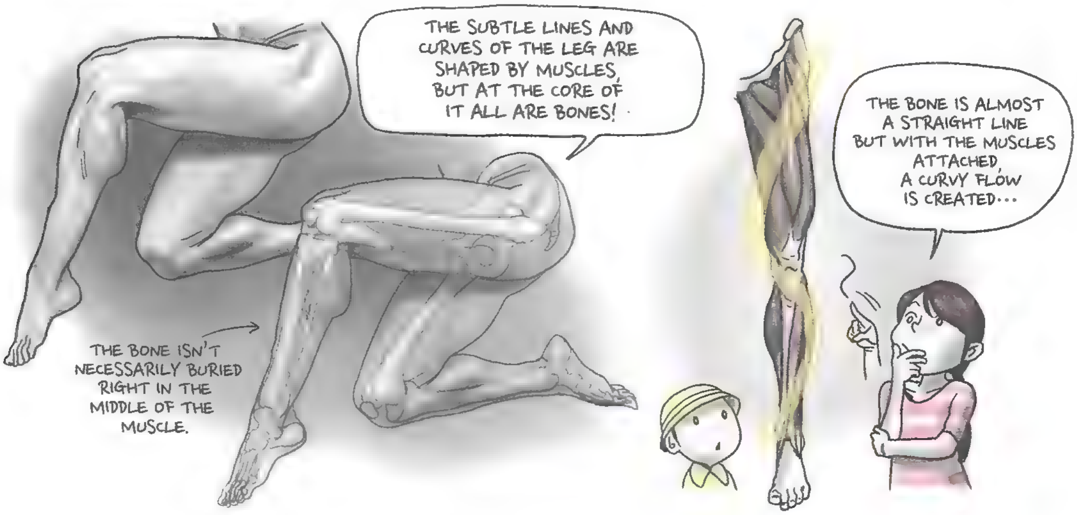
Humans and other animals feel familiar towards things they see more often, which in turn gives them a sense of comfort and stability. This becomes the default state, and the default state is like a cradle that all living things yearn for. This series of stream of consciousness is what we define as beauty. So, beauty isn't necessarily a matter of functionality, but possibly about how long you stuck around and how much attention you drew. Ultimately, it's all about survival.

Humanity will never cease to pursue beauty. But the subject and value of beauty can vary based on survival needs, so how about we start developing a discerning eye to see a broad range of beauties?

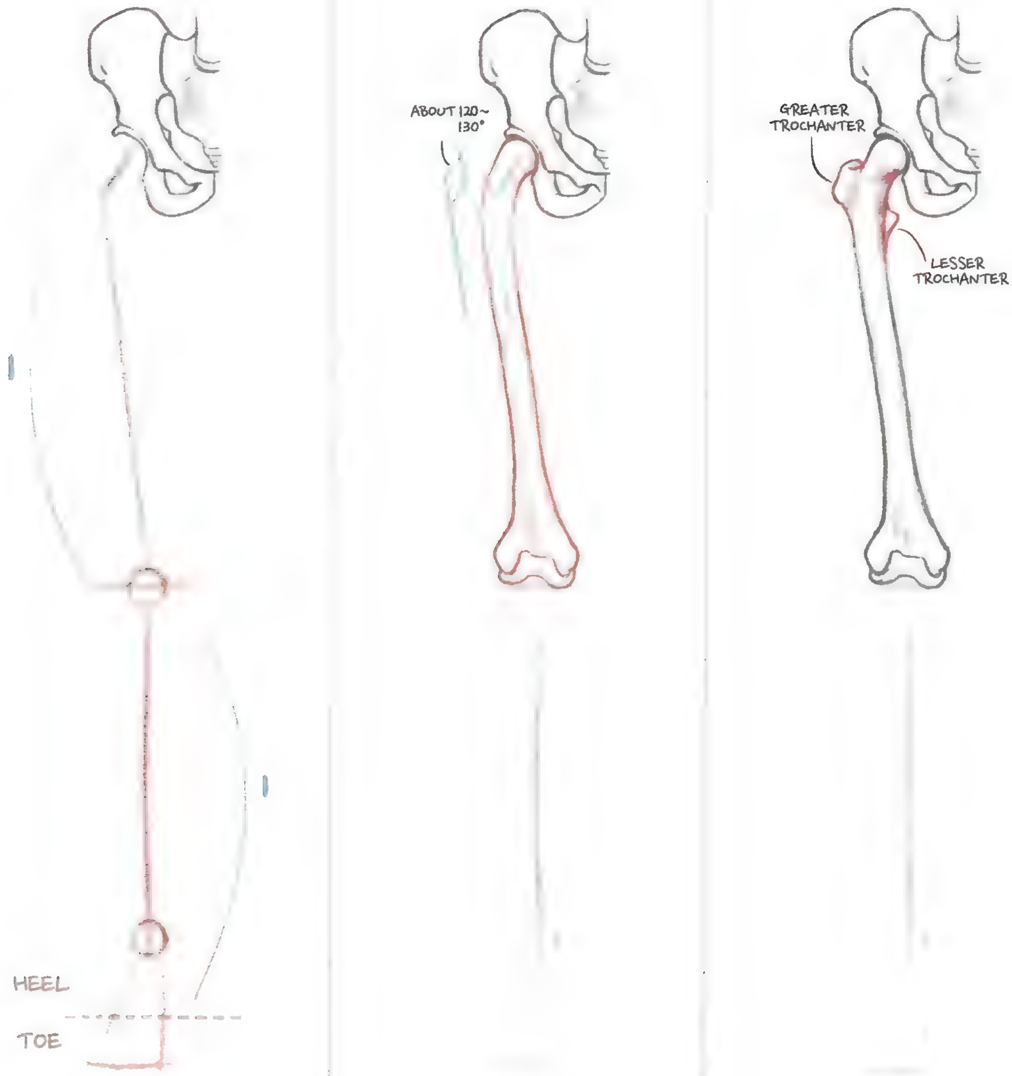
■Let's Draw the Legs

Now it's time to draw the legs. One of the most difficult things for me when I went to art school was drawing legs, especially female legs. Unlike the arms, legs have more flesh and muscles and they are oddly rounded, making them harder to draw.

The leg's 'curves' are like a mirage that is difficult to grasp. Even a well-seasoned body anatomy illustrator cannot express the legs in one go. The leg's 'curves' or 'flow' are formed by the muscles. Since these muscles are attached to the bones, let us first try drawing the bones.



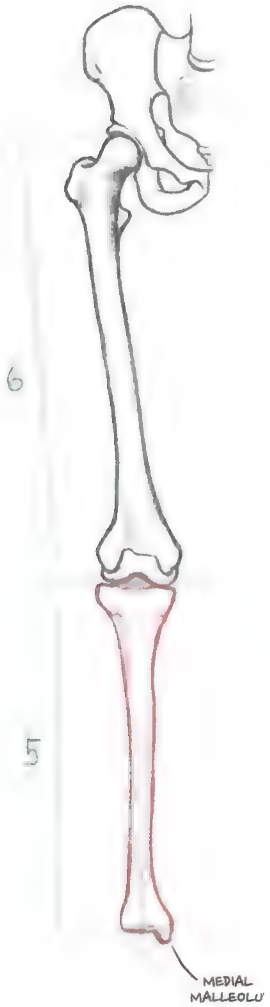
❶ Drawing the Front View of the Leg

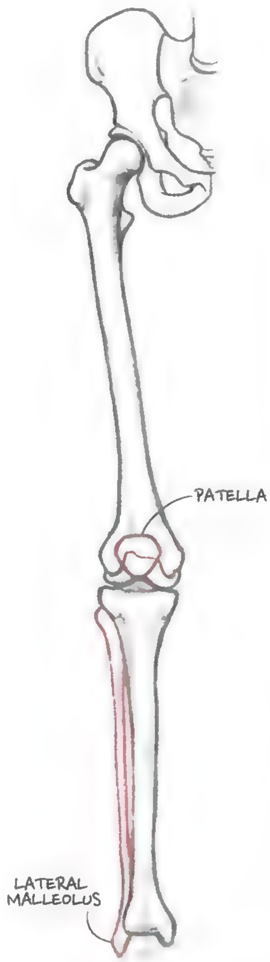


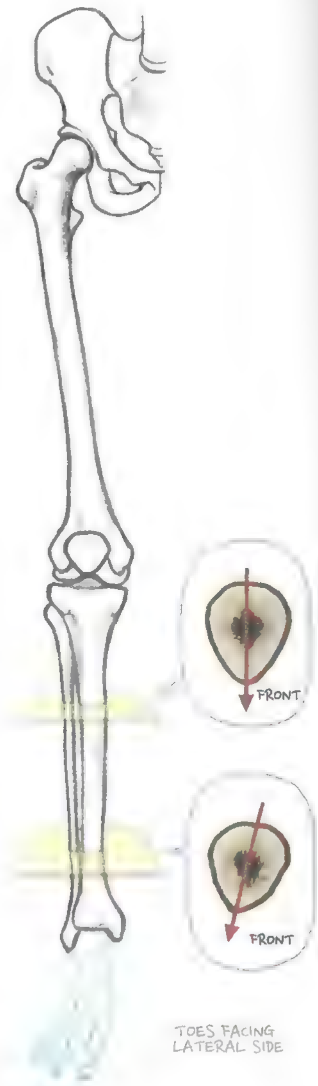
01. Draw the pelvis first, and sketch a line of reference for the leg. The shank is supposed to be longer than the thigh, but if you add feet (at the heel) to the shank, the combined length is similar to the thigh.

02. Start drawing the thigh (femur). It comes down from either end of the pelvis, the top part (neck of femur) is slightly r-curved while the bottom part tilts inwards.

03. At the top of the femur, or the neck of femur, draw the greater trochanter (lateral side) and the lesser trochanter (medial side) around the neck.







04. Now we draw the tibia. The ratio of thigh to shank is 6:5. Don't forget to include a depiction of the anterior border of the femur, as well as the medial malleolus at the bottom of the tibia.

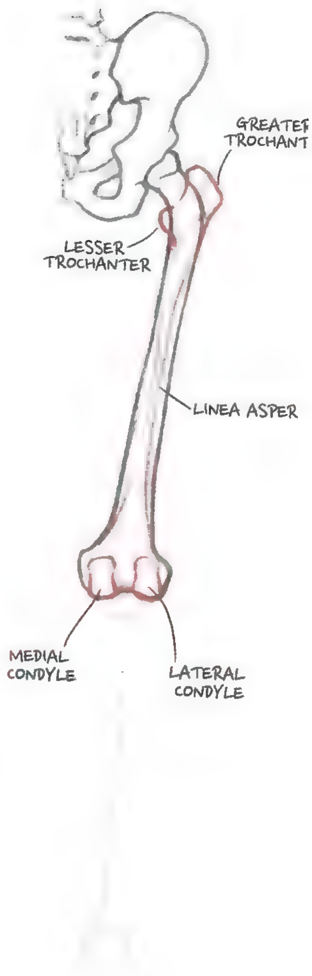
05. Using the patella(kneecap) and the tibia as points of reference, draw the fibula on the lateral side. Remember the lateral malleolus at the bottom of the fibula is slightly lower than the medial malleolus.

06. Now the bones of foot have been drawn in. Remember that the anterior border of the tibia is slightly twisted toward the lateral side, which means toes should also be facing the lateral side, not the front.

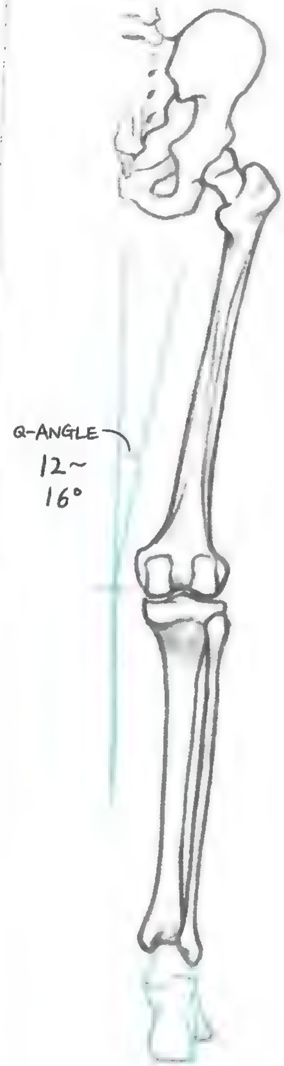
❷ Drawing the Rear View of the Leg

01. Similar to the front view, we start with the line of reference. An easier approach is to figure out the length you want, split it in half (thigh and shank), and divide the ankle at the bottom of the shank.

02. Using the line of reference, draw in the femur. So far, it's very similar to the front view.



03. Draw in detailed features of the femur: greater and lesser trochanters at the top, the linear aspera running down the whole bone, and lateral and medial condyles where it meets the tibia.



04. Draw the tibia. Unlike the front with the anterior border, the rear is rather flat so there are no special details that need to be emphasized.

05. Draw the fibula on the lateral side of the tibia. Remember that the fibula is located somewhat behind the tibia.

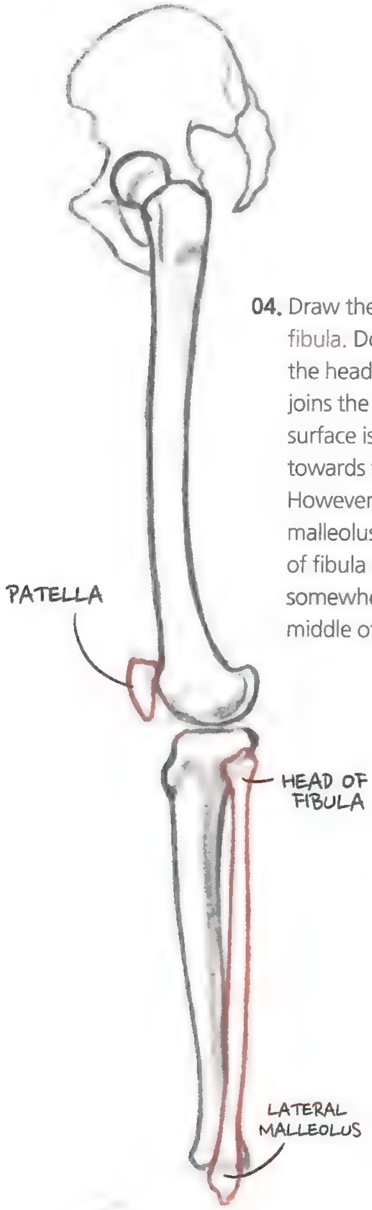
06. Once you draw the bones of foot, this is what the whole rear view of leg looks like.

❸ Drawing the Side View of the Leg

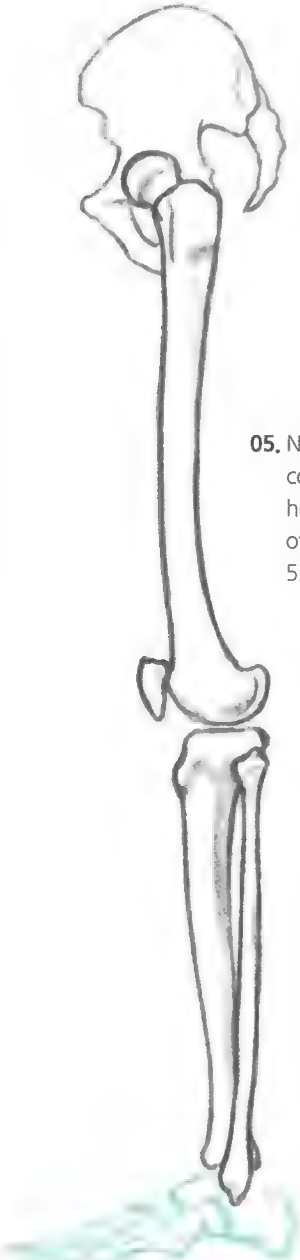
01. Once again, start with the overall proportions. For the arm we looked at the thoracic cage to estimate the size, but the leg doesn't have such a point of reference, which is why we need a line of reference.

02. Draw the femur. The head leans slightly forward while the condyle at the bottom sticks out towards the back, subsequently forming an S for the side view of the femur.

03. Now we draw the tibia. Draw in the tibial tuberosity, which is protruding at the top towards the front, as well as the fibular articular surface and the fibular notch towards the back.



04. Draw the patella and fibula. Don't forget that the head of fibula that joins the fibular articular surface is attached towards the back. However, the lateral malleolus at the bottom of fibula is attached somewhere in the middle of tibia.



05. Now the drawing is complete. For details on how to draw the bones of foot, refer to page 557.

'Ghost' concept illustration / painter 8 /2004

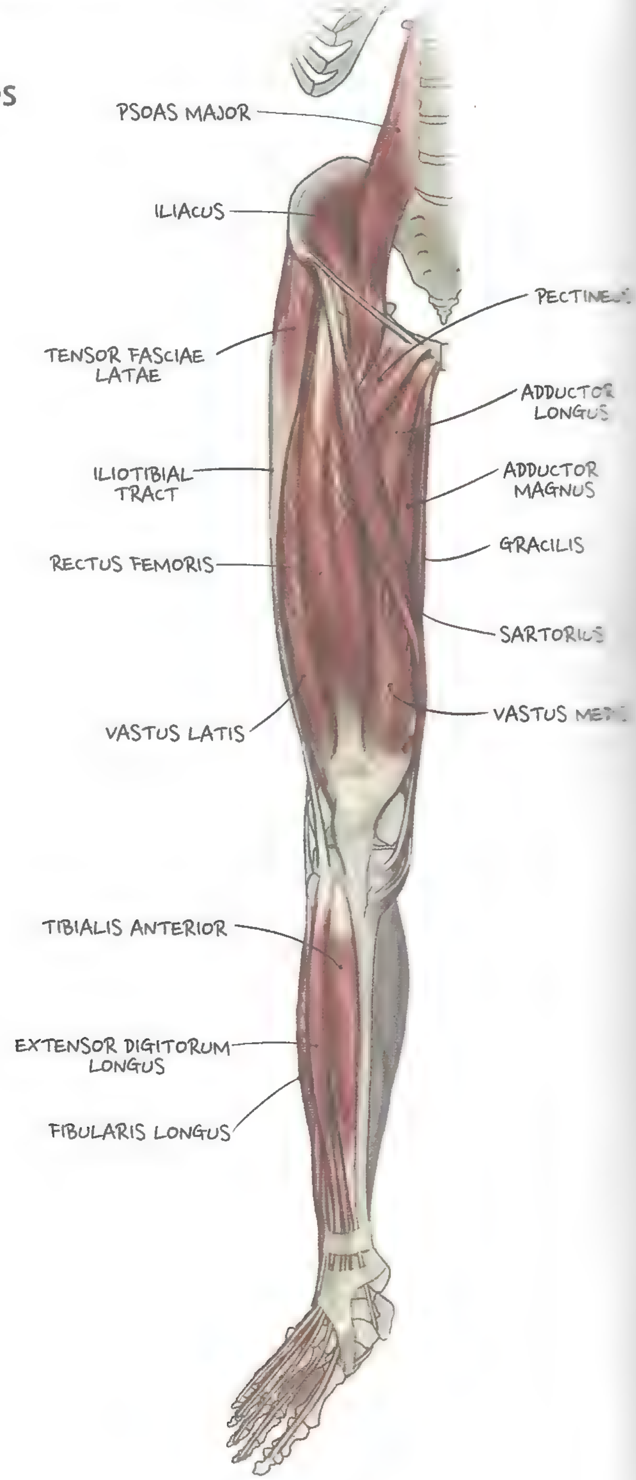
As with all vertebrates, the physical characteristic of a person is best visible in profile view. Of the body, the legs receive a lot of attention because they not only take up more than half the body, but also conjure up the image of movement. Therefore, when drawing the full body, how you express the legs, which are a sizable structure of the body, becomes very important. The subtle curvature of the legs itself has an attraction that draws the eyes.

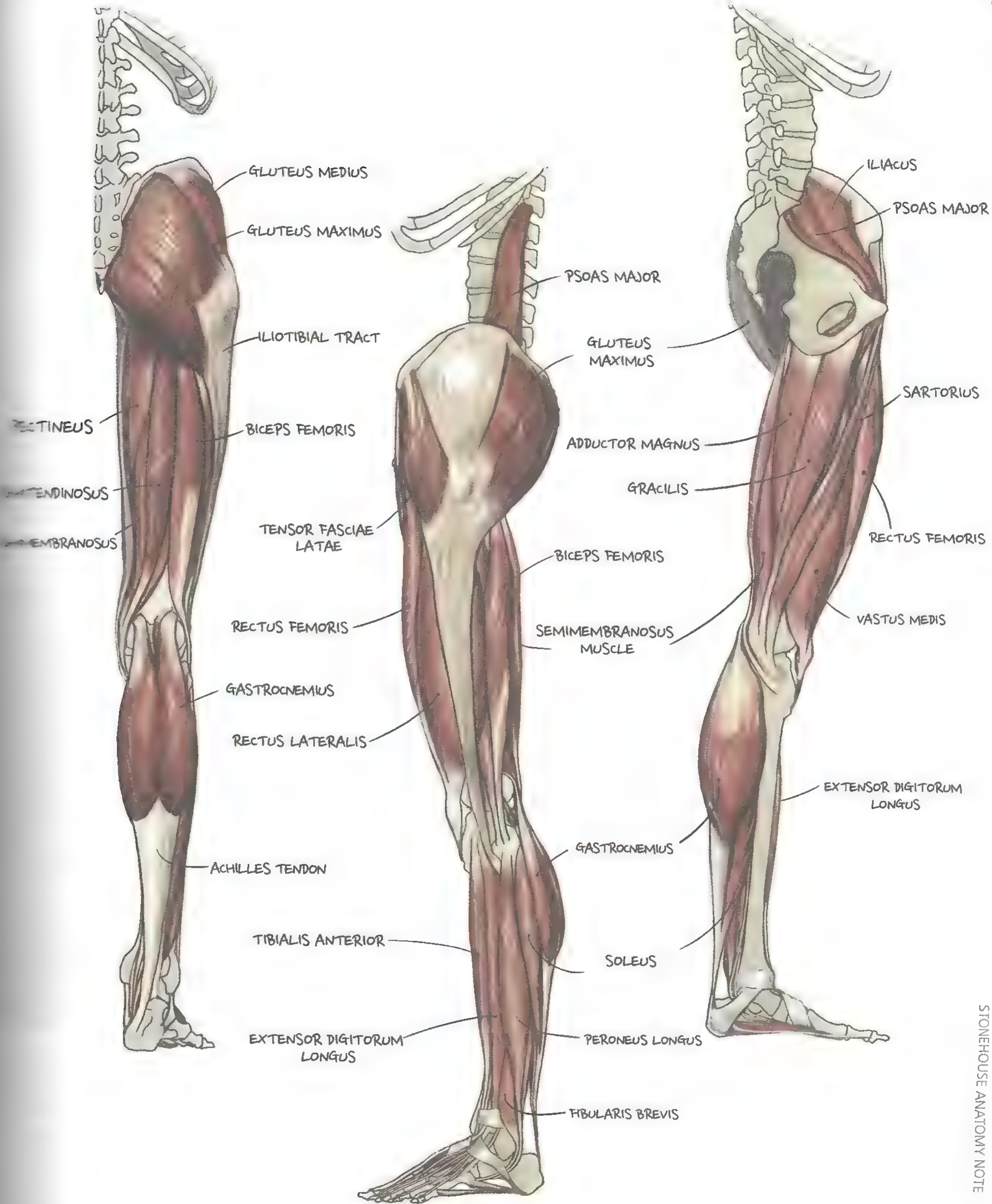
Leg Muscles

Overall Shape of Leg Muscles

Most of the muscles of the leg are long and slender, just like the arm. But the functionality is relatively simple compared to the arm, and a clear distinction among the leg muscles makes it easier to learn them.

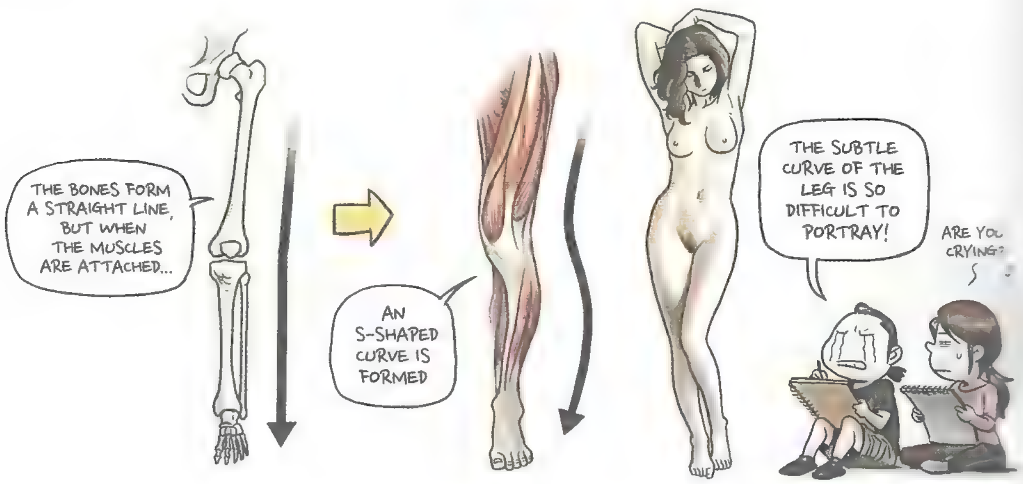
Having said that, I know the drawing can be intimidating. Similar to how we did earlier, let us look at the muscles from different angles and move on.



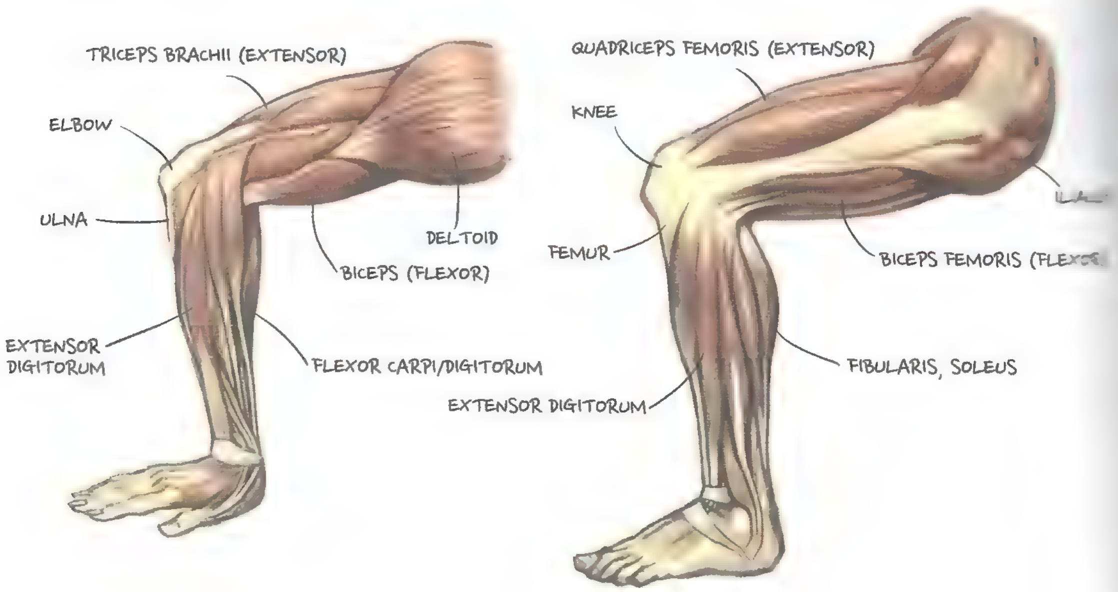

GLUTEUS MEDIUS
GLUTEUS MAXIMUS
ILIOTIBIAL TRACT
BICEPS FEMORIS
GASTROCNEMIUS
ACHILLES TENDON
PSOAS MAJOR
GLUTEUS MAXIMUS
TENSOR FASCIAE LATAE
BICEPS FEMORIS
RECTUS FEMORIS
SEMIMEMBRANOSUS MUSCLE
RECTUS LATERALIS
GASTROCNEMIUS
TIBIALIS ANTERIOR
SOLEUS
EXTENSOR DIGITORUM LONGUS
PERONEUS LONGUS
FIBULARIS BREVIS
ILIACUS
PSOAS MAJOR
SARTORIUS
ADDUCTOR MAGNUS
GRACILIS
RECTUS FEMORIS
VASTUS MEDIS
EXTENSOR DIGITORUM LONGUS

■Secret of the S-curve

Leg is a big section of the body, taking up more than half of the body. Thus, many of the m... are big and weighty. This gives legs a charming curve that wasn't there before when we loo... at just the bones. This is one of the reasons that artists have always paid attention to legs in th... history of art.



Muscles of the legs may play a simpler role compared to the arm but are very similar in functionality. After all, arms and legs are homologous organs. Leg muscles share many similarities with arm muscles, so once again, this should be easy if you remember what we learned about the arm.



However, legs need to produce strength several times greater than arms. That is why legs are much bigger and there is a differnce between the thickness of the extensor and flexor muscles attached at the front and back of the bones. These muscles are what create the unique curvature of the legs.

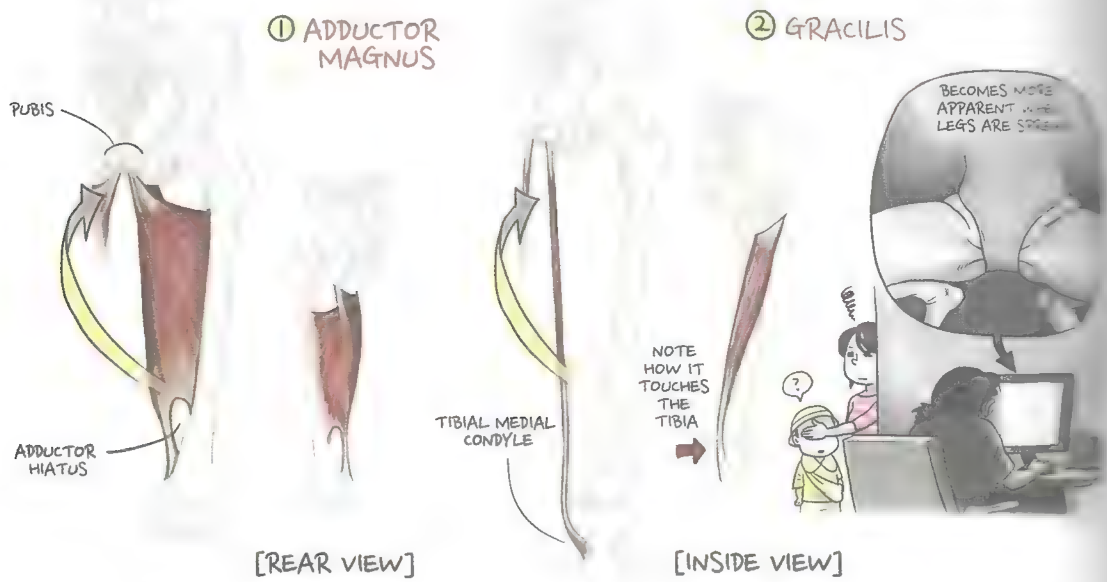
The thigh has well-developed front and medial muscles while the shank has well-developed back and lateral muscles. This is because it is imperative to lift the thighs and heels when walking. That is why the human legs take the shape of a low-curved 'S' shape both in the front and back.

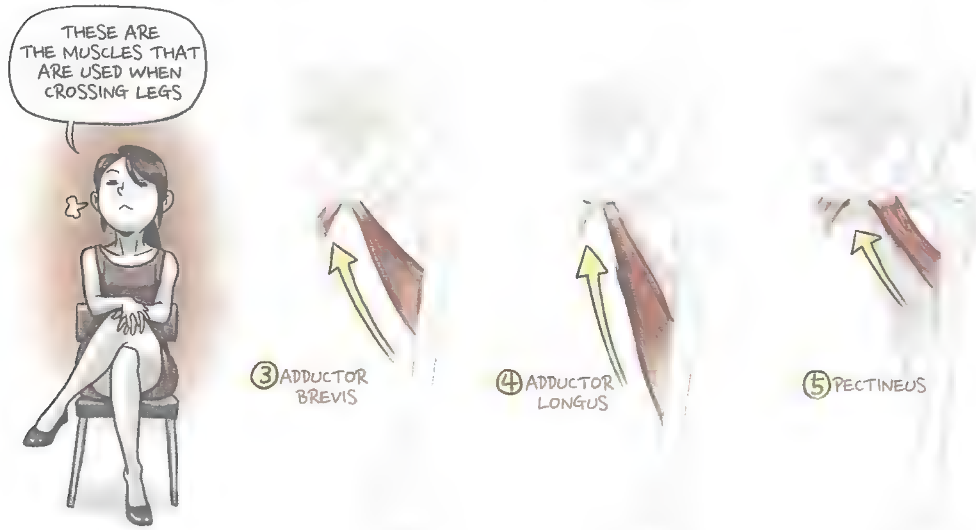
human legs probably evolved to have an S-curve to accommodate walking and running in …ing position. Thanks to this, humans gained an unexpected point of attraction. Now let us … at the factors that create the S-curve of the leg.

■Major Muscles of the Leg

❶ Muscles for Leg Adduction: Adductor Group

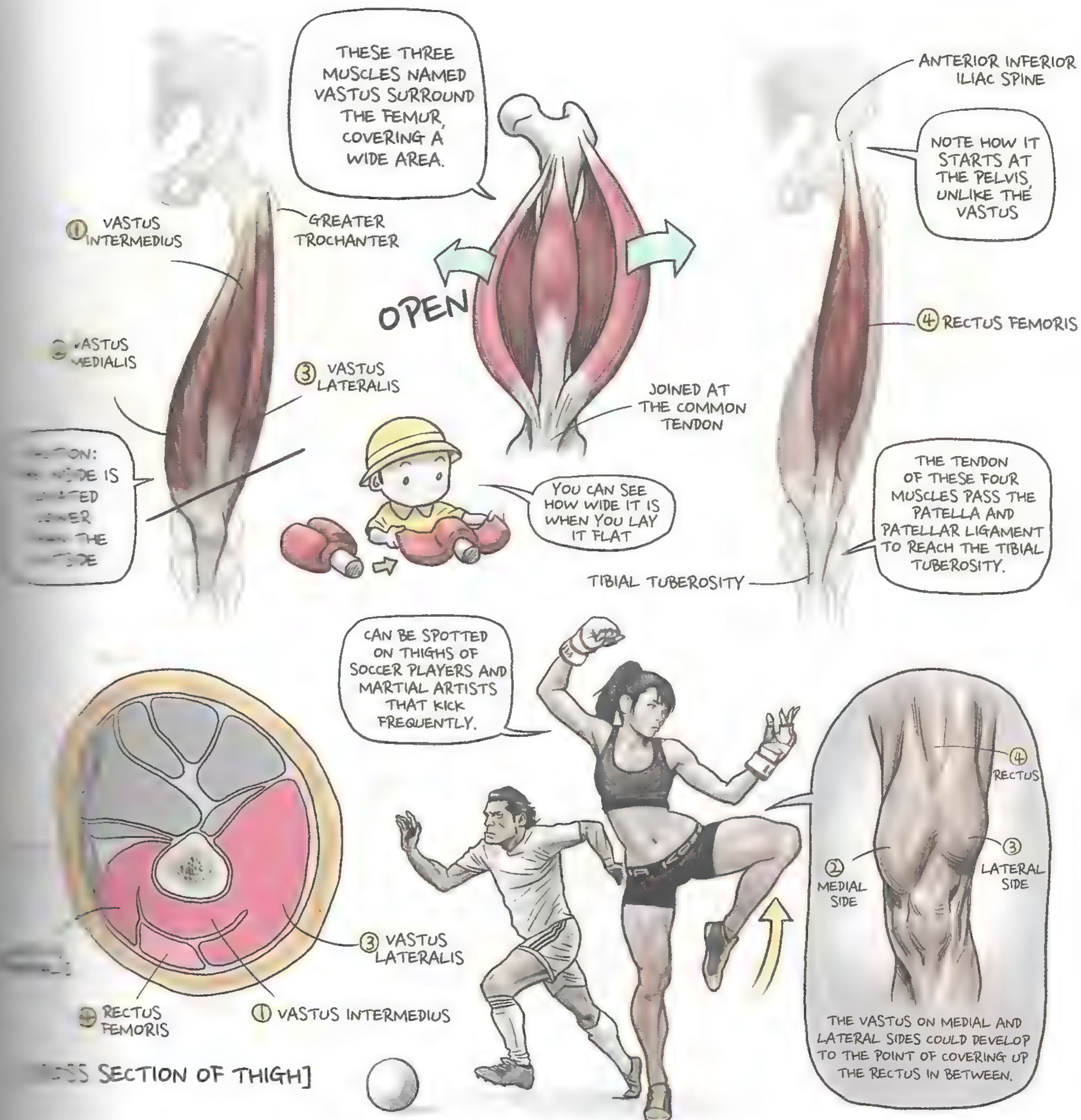
The motion to gather the legs closer to the body could be considered the same thing as [illegible] the legs inward depending on the perspective. So, these muscles pretty much play the [illegible] role as the coracobrachialis or pectoralis muscles that are used to pull the arms inward. [illegible] these muscles are together called the adductor group. They form the femoral triangle, [illegible] from the inside of the lumbar vertebrae and the pelvis, the bottom of the pubis connecting [illegible] inside of the femur.





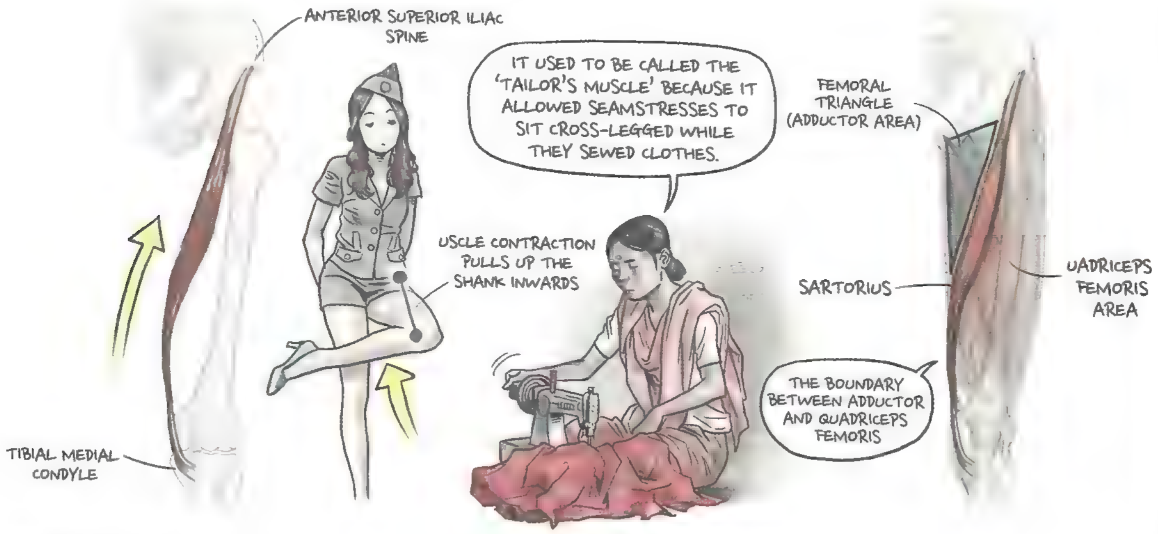
❷ Muscles for Leg Extension: Quadriceps Femoris

These are the muscles that straighten out the thigh and shank in a straight line. They are strong muscles used when kicking, so they are very distinct on the legs of soccer players. They consist of three vastus muscles thickly surrounding the femur, and the rectus femoris that starts at the pelvis, the pelvic girdle, and extends to the tibia below the knee. *The head of these four muscles start at different points but are joined together by the same tendon (common tendon) as they all pass through the tibial tuberosity.*



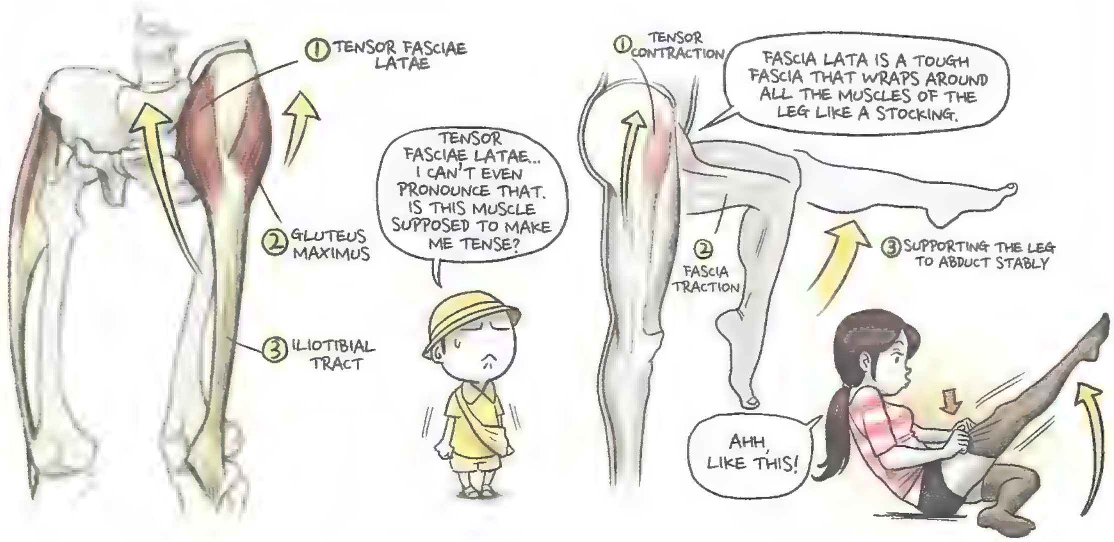
③ Muscles for Cross-legged Sitting: Sartorius

The longest muscle in the human body (about 60cm) that acts as the boundary between the adductor and vastus. It starts at the pelvis and runs all the way down to the shank and plays various functions. The most important function is pushing the leg in the outward direction, as well as lifting then bending the leg. This is the muscle that enables us to sit cross-legged and play hacky sack.



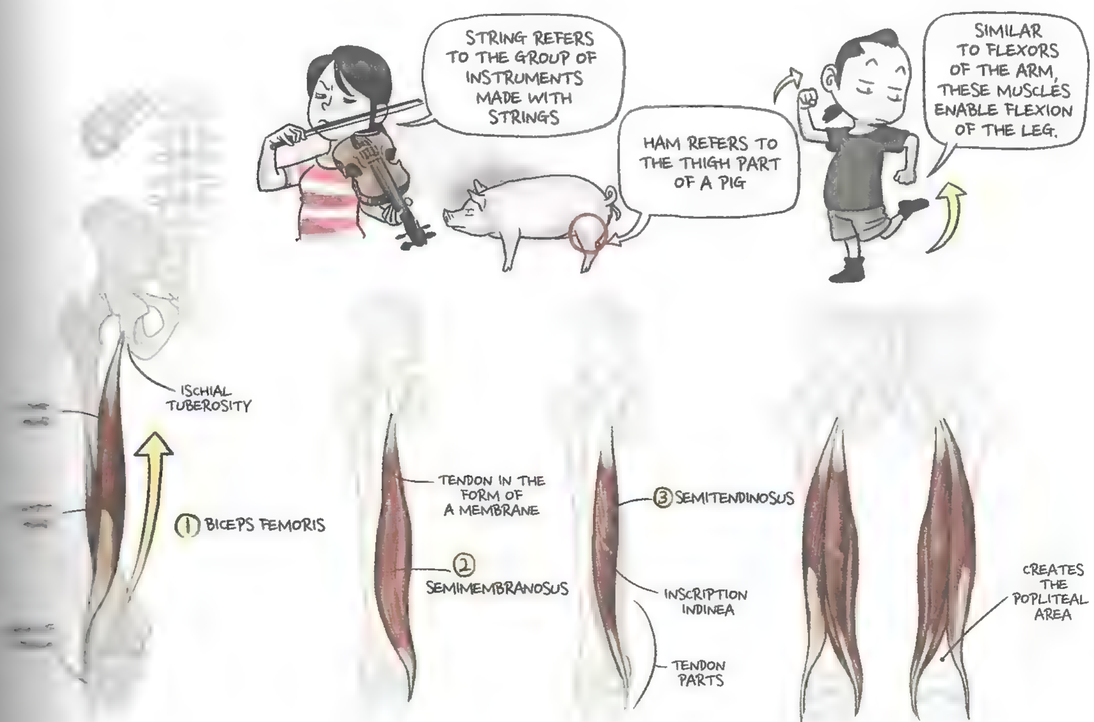
④ Muscles for Leg Abduction: Tensor fasciae latae, Gluteus

Leg muscles that are equivalent to the deltoid of the arm. They start at the lateral side of the pelvis and join a long ligament called the iliotibial tract. In addition to lifting (abducting) the leg toward the lateral side, they also play a crucial role in maintaining an upright position and walking.



Muscles for Leg Flexion: Hamstring

-amstring is a term that includes the muscles on the rear side of the thigh – biceps femoris, -tendinosus, and semimembranosus. The word hamstring is derived from the fact that the -scles are long and slender like a string. Hamstring is the counterpart to the quadriceps -oris on the front of the thigh and pulls the whole leg back or pulls up the shank for flexion. It is -e equivalent to the biceps brachii of the arm.

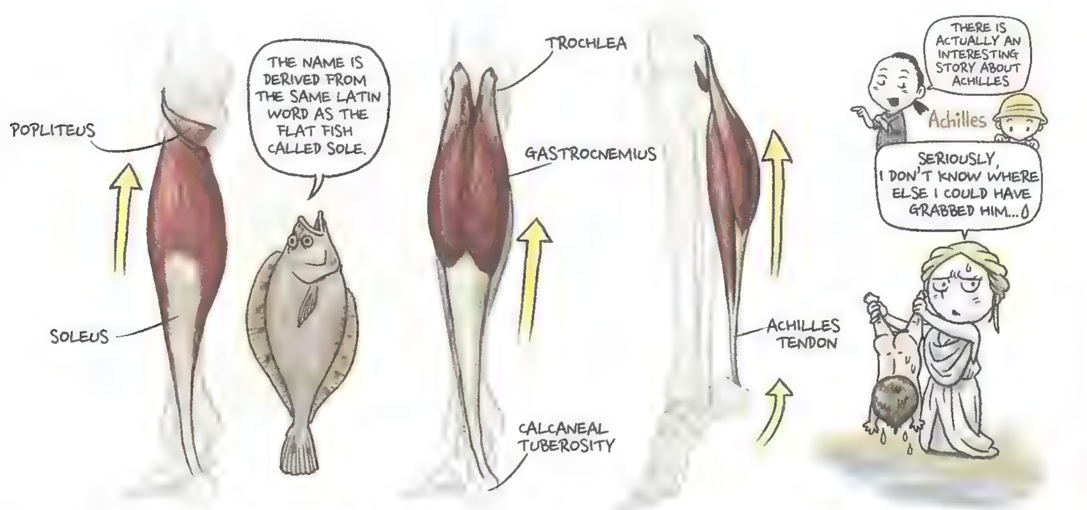


Wait! The 'Pes Anserinus' of the knee

Let's look at the medial side of the knee. The tendons of the sartorius, gracilis and semitendinosus muscles conjoin and are inserted into the medial condyle on the superomedial aspect of the tibia. This is part of the tibia. The shape of the three tendons attached in order from top to bottom looks like the beak of a goose, so it is called pes anserinus ('goose foot'). It is the milestone of the medial side of the knee, so we should remember it.

❻ Muscles to Raise the Heel: Triceps surae

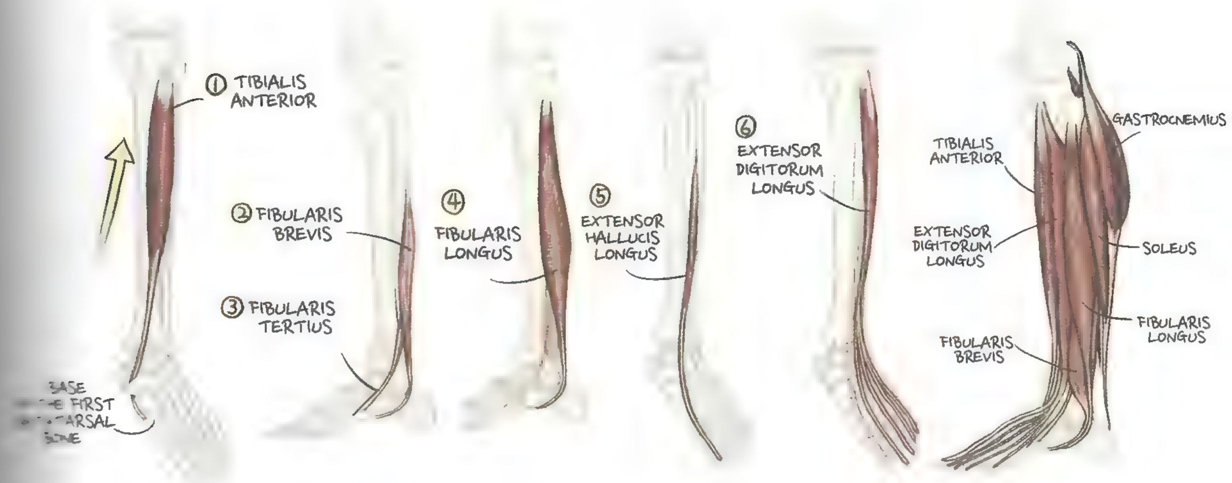
Located on the rear of the calf, this is the part of the calf that is bulging out. It consists of the two-headed gastrocnemius that starts at the articular surface on the rear end of the femur and the soleus which starts on the rear end of the tibia. These two muscles meet at the lower end and have a common tendon touching the heel. Referred to as the Achilles tendon, this tendon plays a crucial role in walking by lifting the heel.

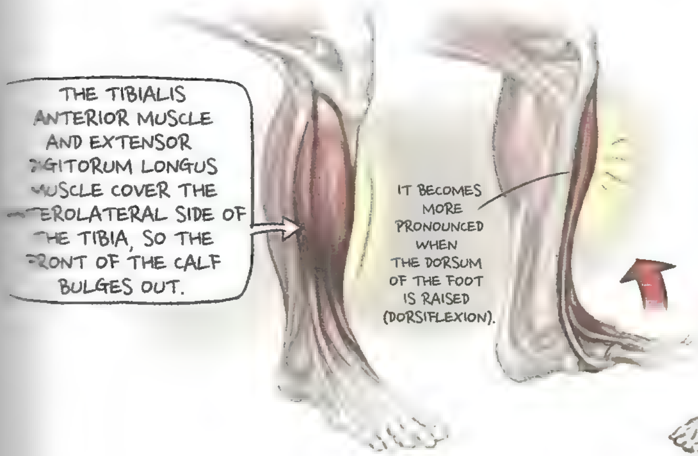


In Greek mythology, Achilles's mother Thetis, a goddess of water, took him to the River Styx and dipped his body into the water to give him powers of invulnerability.

❼ Muscles to Raise Instep and Toe: Tibialis anterior, fibularis, extensor digitorum

These are muscles that do the opposite of the triceps surae and the flexor digitorum that we just saw. It enables dorsiflexion to raise the instep, and the tibialis anterior appears very clearly during this motion.

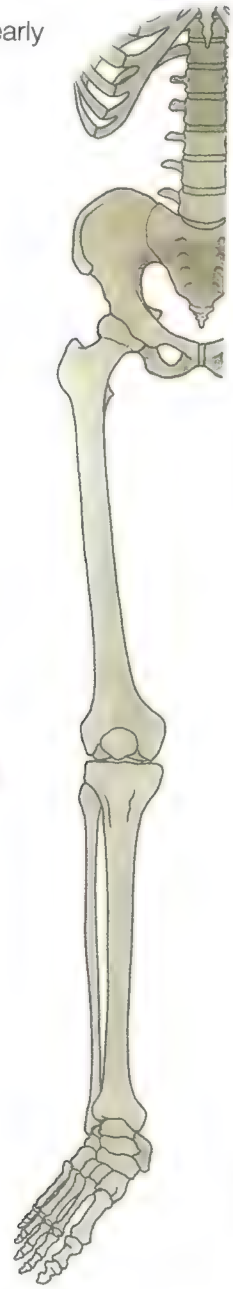




LET'S CHECK THE MUSCLES IN FRONT OF THE CALVES.

■Let's Add Muscles to Legs

These are muscles that do the opposite of the triceps surae and flexor digitorum that we just saw. It enables dorsiflexion to raise the instep, and the tibialis anterior appears very clearly during this motion.



❶ Bones of lower limb

01. Hamstring

(refer to page 499)

02. Psoas major, iliacus muscles

03. Adductor magnus muscle

04. Gracilis muscle

05. Adductor brevis muscle

06. Adductor longus muscle

07. Pectineus muscle

08. Gluteus maximus muscle, iliotibial tract

09. Vastus intermedius muscle

10. Vastus lateralis, medialis muscles

11. Rectus femoris muscle

12. Quadriceps femoris muscle

13. Sartorius muscle

14. yTensor fasciae latae muscle

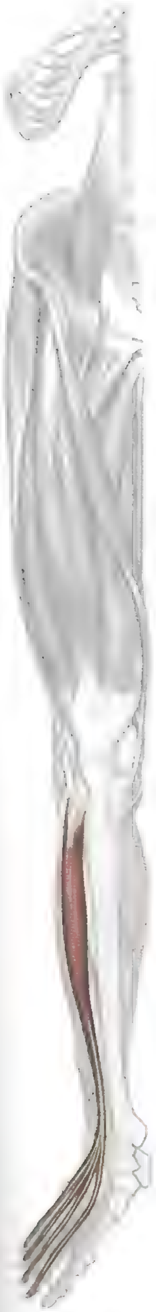
15. Calf muscle

(refer to page 500)

16. Peroneus longus muscle

17. peroneus brevis muscle

18. Peroneus tertius/ extensor pollicis longus muscle



19. Extensor digitorum longus muscle

20. Tibialis anterior muscle

21. Inguinal ligament, superior/inferior extensor retinaculum

22. Complete front view of the leg

❷ **Rear view of the bones of leg**
(Bones of lower limb)

01. Anterior adductor
(Adductor group: refer to page 496)

02. Vastus medialis muscle

03. Adductor magnus muscle

04. Semimembranosus muscle

05. Biceps femoris muscle

06. Semitendinous muscle

07. Hamstring
(refer to page 499)

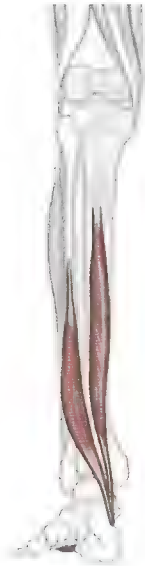
08. Gluteus minimus muscle

09. Gluteus medius muscle

10. Gluteus maximus muscle

11. Extensor digitorum longus muscle

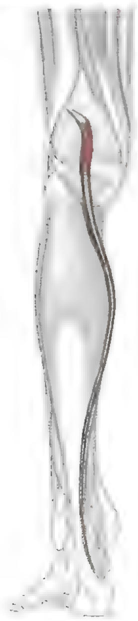
12. Peroneus longus muscle



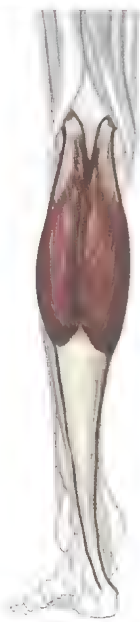
13. Flexor pollicis, digitorum longus muscles

14. Popliteus, tibialis posterior muscles

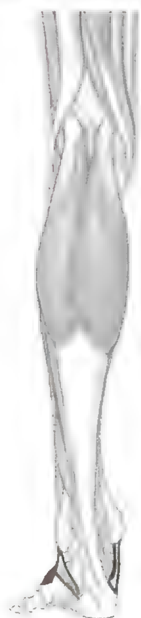
15. Soleus muscle



16. Plantaris muscle

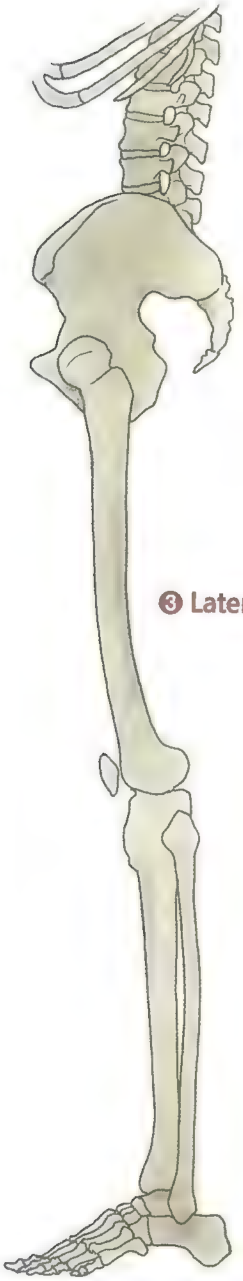


17. Gastrocnemius muscle

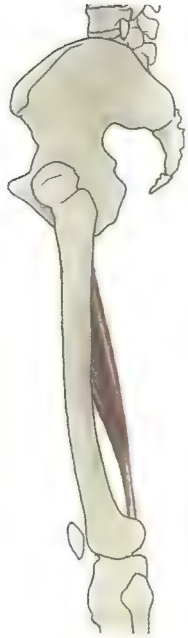


18. Inferior extensor retinaculum

19. Complete rear view of the leg



❸ Lateral view of the leg



01. Gracilis muscle

02. Anterior adductor
(Adductor group:
refer to page 496)

03. Psoas major muscle

04. Sartorius muscle

05. Adductor magnus muscle

06. Semitendinous muscle

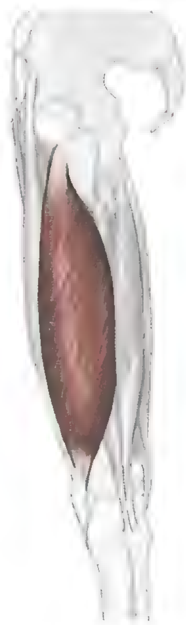
07. Semimembranosus muscle

08. Biceps femoris muscle

09. Vastus medialis muscle

10. Vastus intermedius muscle

11. Rectus femoris muscle



12. Vastus lateralis muscle

13. Gluteus minimus muscle

14. Gluteus medius muscle

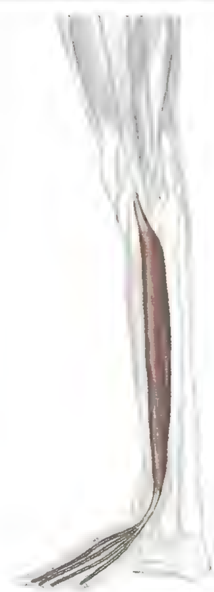
15. Tensor fasciae latae/gluteus maximus muscles

16. Iliotibial tract

17. Muscle of instep (page 571), plantaris muscle

18. Tibialis anterior/ peroneus tertius muscle

19. Extensor pollicis longus muscle



20. Extensor digitorum longus muscle

21. Flexor pollicis longus muscle

22. Peroneus brevis/ soleus muscle

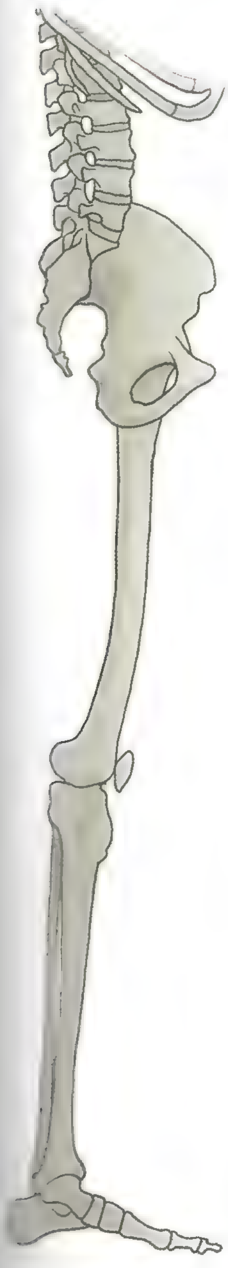
23. Peroneus longus muscle

24. Gastrocnemius muscle

25. Superior/inferior extensor retinaculum

26. Complete lateral view of the leg

❹ Medial view of the leg



01. Pronator teres muscle

(refer to page 573)

02. Peroneus longus/ tibialis posterior muscles

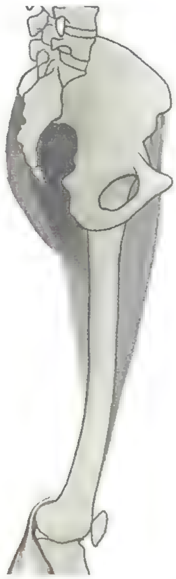
03. Popliteus, peroneus brevis, extensor digitorum longus muscles

04. Flexor pollicis, digitorum longus muscles

05. soleus muscle

06. Plantaris muscle

07. Gastrocnemius muscle



08. Gluteus maximus muscle, iliotibial tract

09. Vastus lateralis muscle

10. Vastus intermedius muscle

11. Rectus femoris muscle

12. Iliopsoas muscle

13. Vastus medialis muscle

14. Anterior adductor

(refer to page 496)

15. Biceps femoris muscle

16. Semitendinous muscle

17. Semimembranosus muscle

18. Adductor magnus muscle

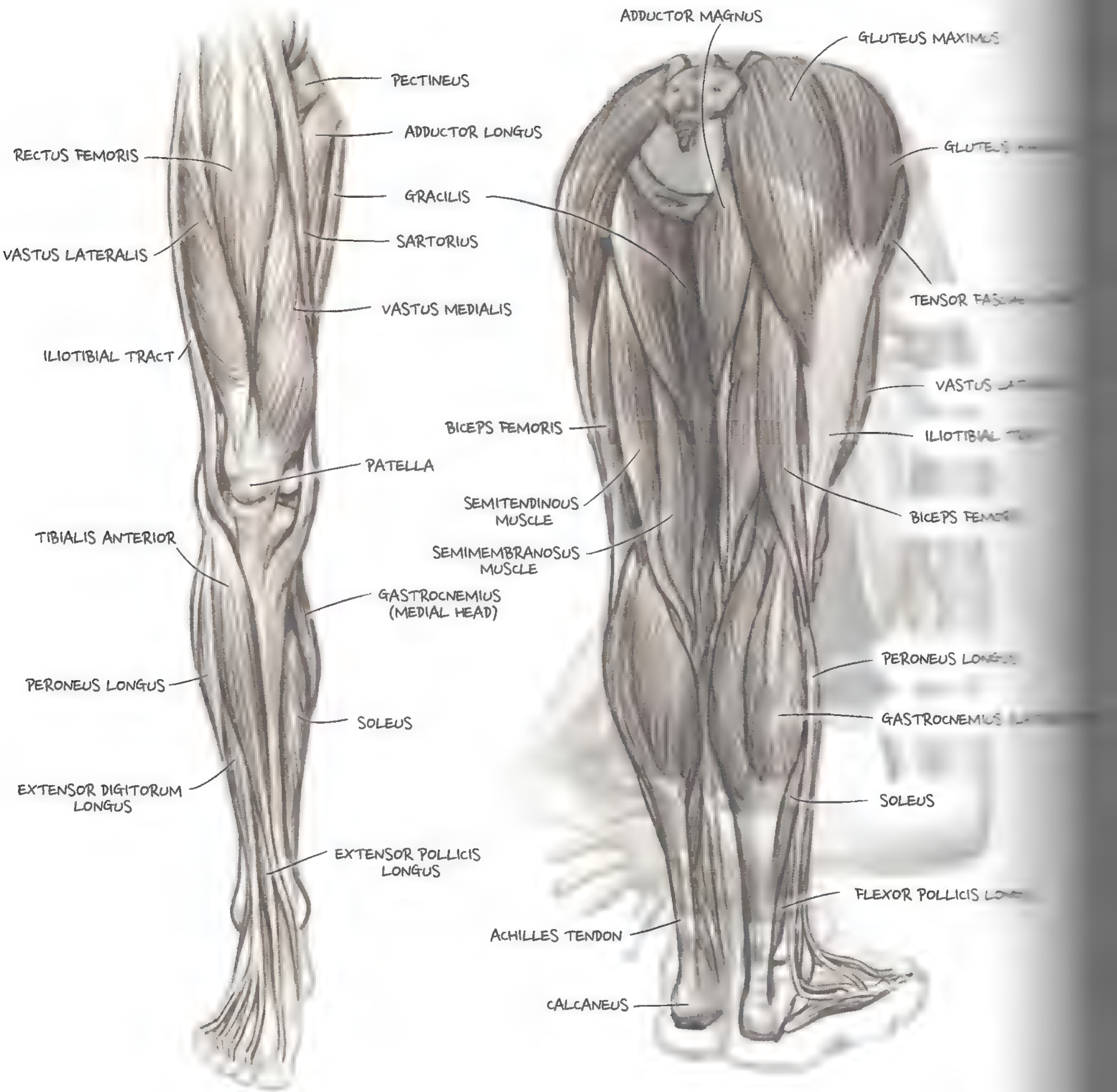
19. Gracilis muscle

20. Sartorius muscle

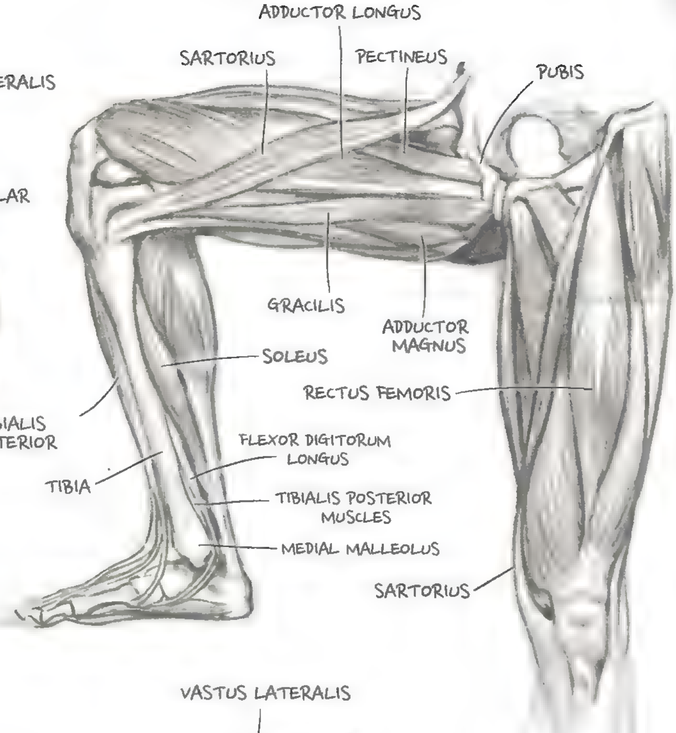
21. Complete medial view of the leg

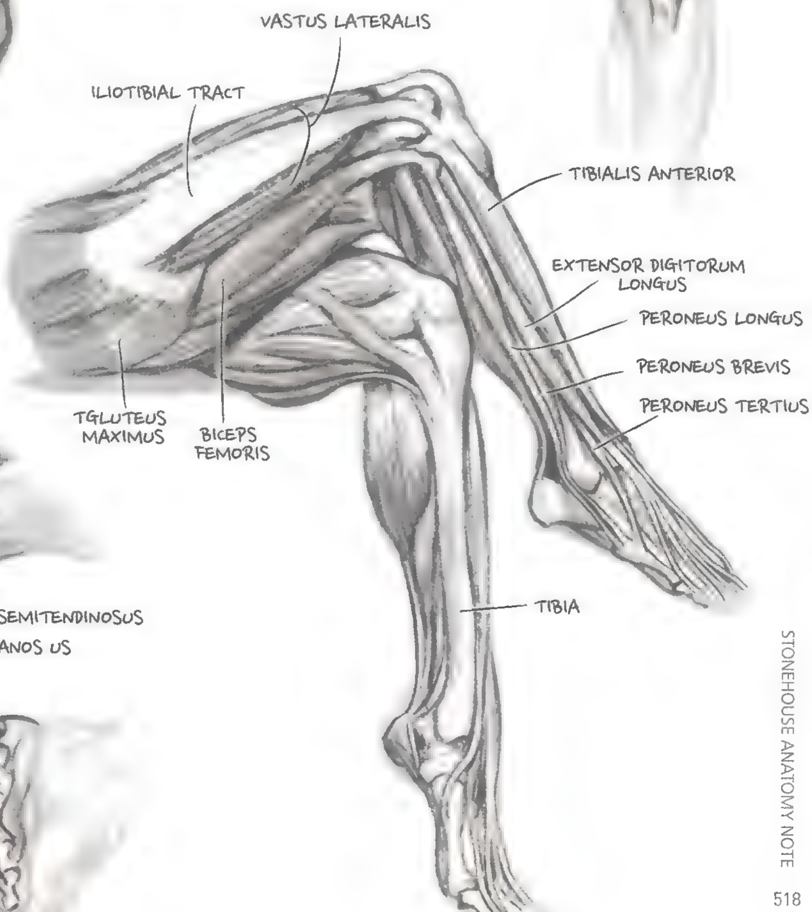
Many Images of Legs

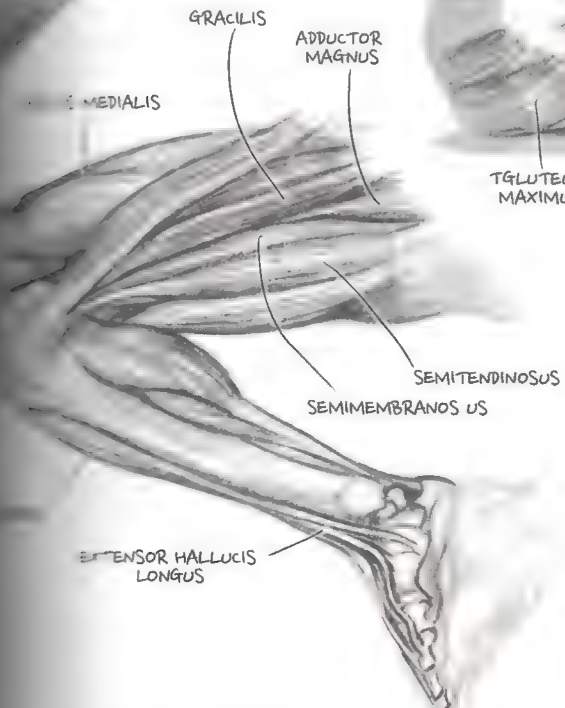
As we briefly touched upon earlier, the many facets of the back are determined not only by how developed the muscles are but also the direction of fiber and appearance of bone and tendon. Despite the fact that the erector spinae is a deep muscle, it can be seen in the back, especially at the waist, when erecting the upper body upright because it is extremely thick. Let us also pay attention to the spinous process that appears between the muscles when the upper body is bent.


PECTINEUS
ADDUCTOR LONGUS
RECTUS FEMORIS
GRACILIS
SARTORIUS
VASTUS LATERALIS
VASTUS MEDIALIS
ILIOTIBIAL TRACT
PATELLA
TIBIALIS ANTERIOR
GASTROCNEMIUS
(MEDIAL HEAD)
PERONEUS LONGUS
SOLEUS
EXTENSOR DIGITORUM
LONGUS
EXTENSOR POLLICIS
LONGUS
ADDUCTOR MAGNUS
GLUTEUS MAXIM
TENSOR
VASTUS
BICEPS FEMORIS
ILIOTIBIAL
SEMITENDINOUS
MUSCLE
BICEPS
SEMIMEMBRANOSUS
MUSCLE
PERONEUS
GASTROCNEMI
SOLEUS
FLEXOR POLLICIS
ACHILLES TENDON
CALCANEUS


ANTERIOR SUPERIOR ILIAC SPINE
TENSOR FASCIA LATAE
VASTUS LATERALIS
FEMUR
PATELLAR
TIBIALIS ANTERIOR
GASTROCNEMIUS


ADDUCTOR LONGUS
SARTORIUS
PECTINEUS
PUBIS
GRACILIS
ADDUCTOR MAGNUS
SOLEUS
RECTUS FEMORIS
FLEXOR DIGITORUM LONGUS
TIBIA
TIBIALIS POSTERIOR MUSCLES
MEDIAL MALLEOLUS
SARTORIUS


VASTUS LATERALIS
ILIOTIBIAL TRACT
TIBIALIS ANTERIOR
EXTENSOR DIGITORUM LONGUS
PERONEUS LONGUS
PERONEUS BREVIS
PERONEUS TERTIUS
TGLUTEUS MAXIMUS
BICEPS FEMORIS
TIBIA


GRACILIS
ADDUCTOR MAGNUS
MEDIALIS
SEMITENDINOSUS
SEMIMEMBRANOS US
ENSOR HALLUCIS LONGUS

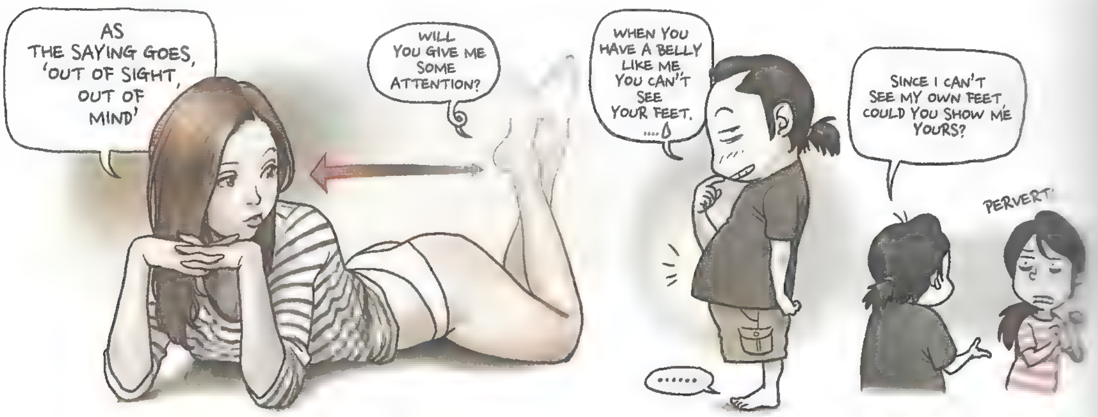
The Foot Supports the Whole Body

■A walking Masterpiece

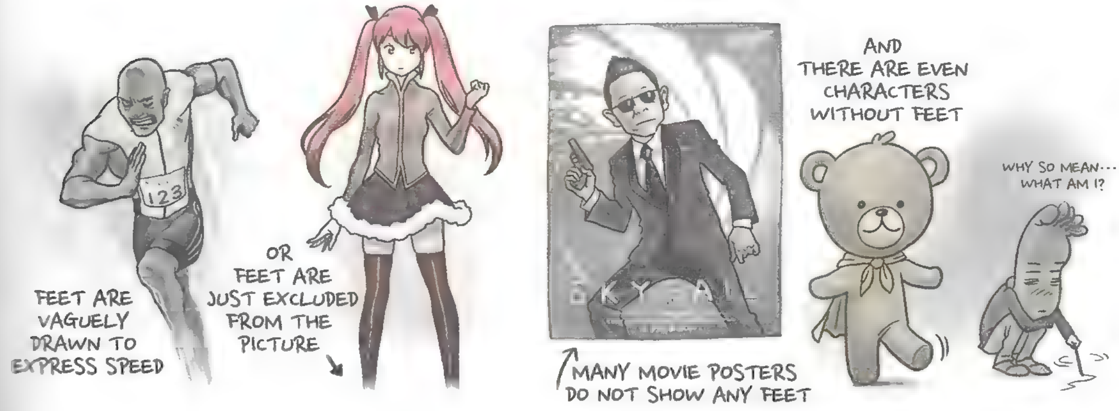
Even a professional cartoonist or an illustrator is caught off guard when asked to draw a
Why is that? Simply put, we never draw it. There are many Korean idioms regarding our
as 'a horse without leg travels fast,' and 'to beg or pray so imploringly that you use both
hands and feet.' As such, the foot is a body part as familiar to us as our hands, but the
we do not draw them often.

<GENERAL IMAGE OF FEET>

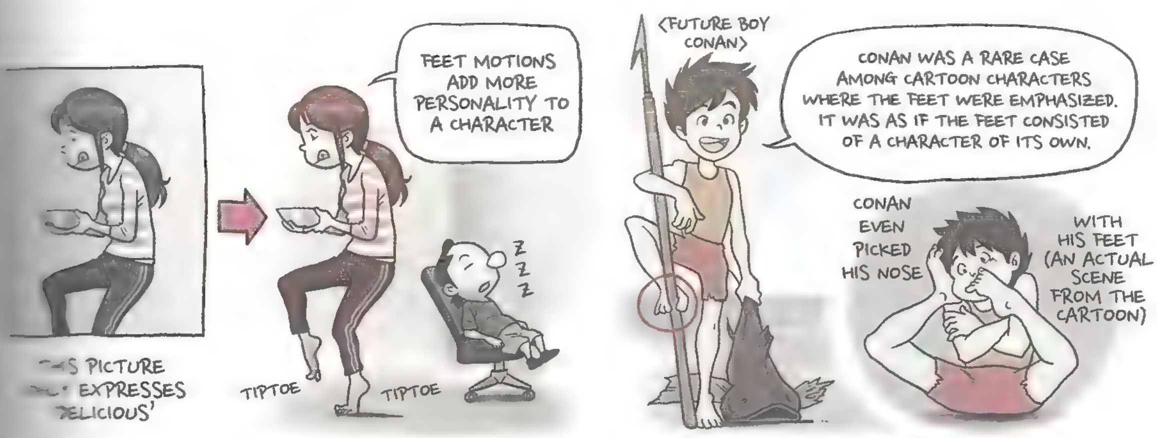
A reason for this is that usually our feet are covered in socks or shoes. The feet have the
sweat glands and are vulnerable to infections like athlete's foot. So, we tend to pay less
to feet, even our own. Also, the feet are located the farthest along our body so we can't see
unless we bend down to see them.



Additionally, feet, unlike hands, are not used for communicative purposes; instead, they are more associated with 'mobility.' That is why illustrators often deemphasize the feet or simply exclude them from drawings. In short, feet are not often drawn or observed.

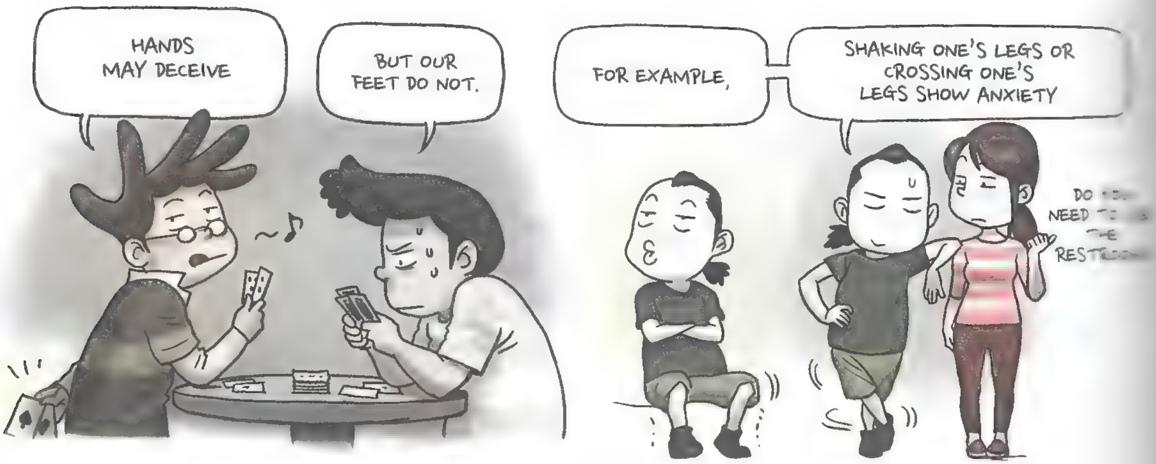


Having said that, if we choose to acknowledge the existence of feet and include them in illustrations with the detail they deserve, we can bring out greater liveliness and expression in characters. This is because while feet represent 'mobility,' which is one of the most important human activities they are also anatomically similar to hands, and could possibly replace them. Anyone with an acting or illustration career should pay attention to feet.

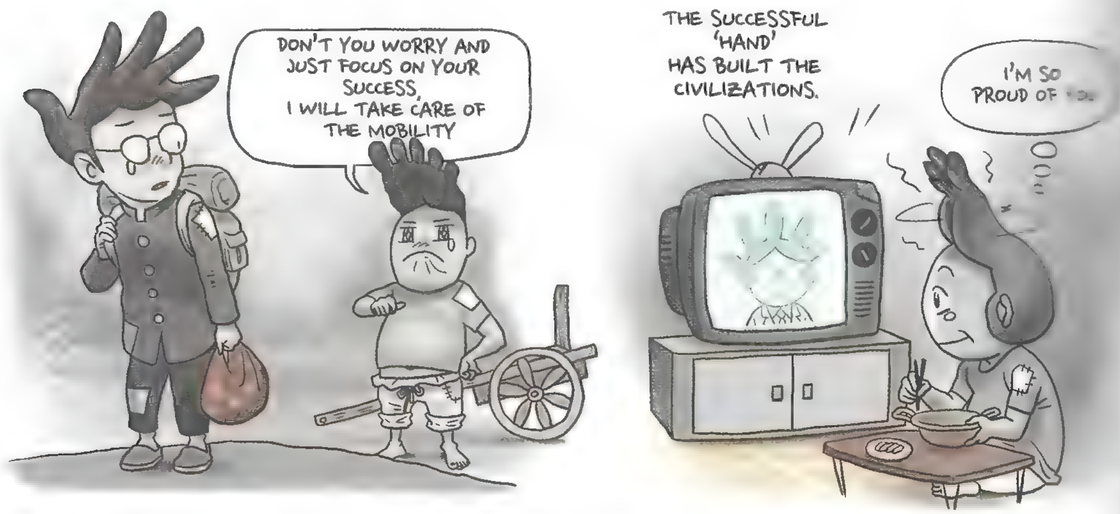


In the 1978 animation by Miyazaki Hayao, Future Boy Conan, the main character Conan uses his feet almost like his hands. Because of this image, Conan gave the impression of being a very active character.

The significance of feet is recognized outside the field of illustrations as well. Although feet have less communicative ability than hands, they are an indicator for the psychological state of a person. People usually focus on facial expressions and hand gestures but seldom pay attention to what their feet are doing, so the feet can be a more accurate indicator of emotional states. For this reason, many behavioral experts say that we should observe the feet when trying to read body language.

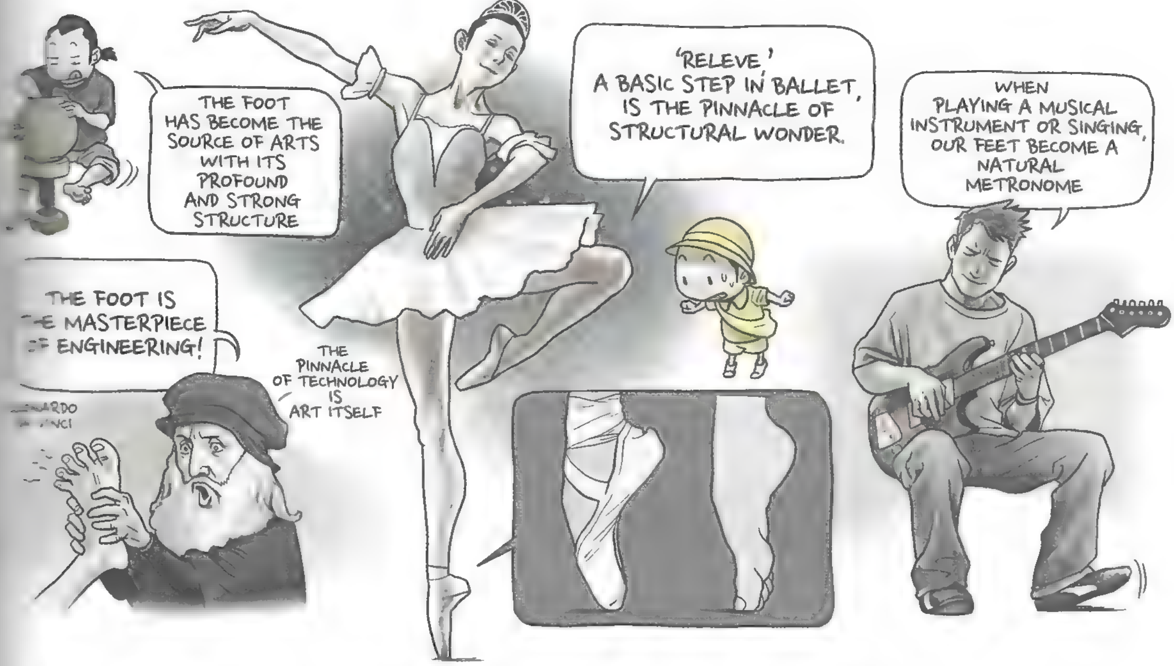


Although living things rely on feet for mobility, which is a very important ability needed for survival, feet do not receive the appreciation they deserve. In particular, the human feet are only used to support body weight, unlike that of other animals that use hands for feet or feet for hands. Thanks to the 'sacrifice' made by human feet, humans were able to develop the most perfect 'hands' among animals. We all know what humanity has achieved using its hands.



Tonight, let's take time to appreciate our feet and give them a massage.

The foot consists of 26 bones, 114 ligaments and 20 muscles. All these parts form a structure that enables humans to stand, walk and run. This structure also absorbs the weight while allowing all these movements. Our foot is not just a pedestal but a supporting crutch that assists humans in making endless postures and movements. As a result, the foot serves as the source of energy that supports humanity in building civilizations and contributes to the arts. We could call the foot an art itself.

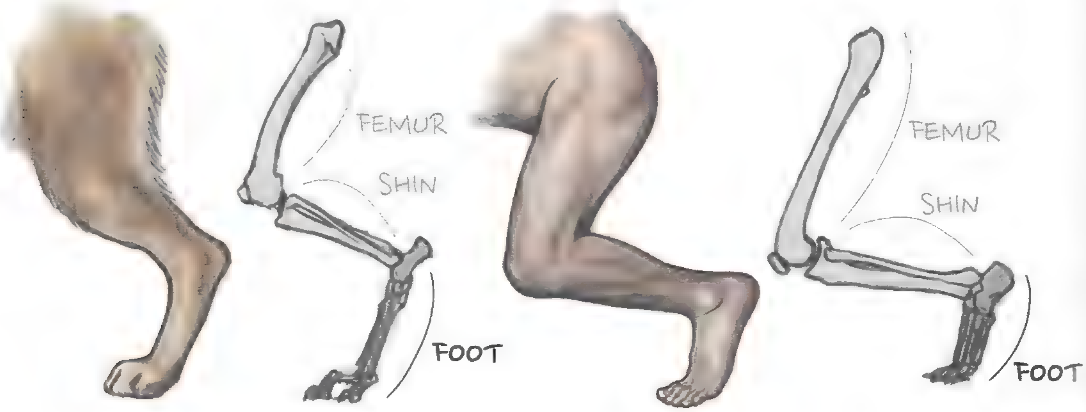


In the Korean language, we often use the term 'foot' in a negative context to express something of poor quality. For example, 'cook with one's foot' 'draw with one's foot' are common derogatory expressions. Koreans also use the word 'dog' or 'dog-like' when expressing something in a derogatory manner. Although, people who love dogs do not use this expression. In this chapter on the foot, you will gain a new appreciation for this body part. Maybe by the time we reach the end of this chapter, you will have a different perspective on the word 'foot' and stop using it in a negative context.

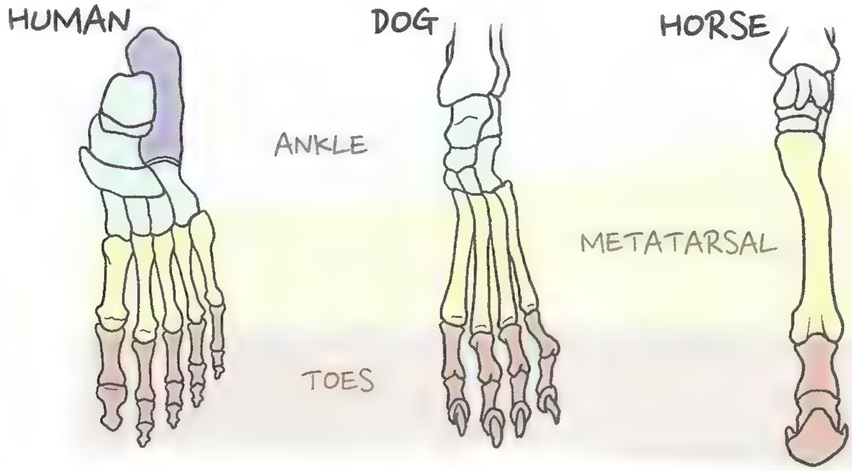
Memory of a Dog

As I mentioned in the prologue, I have always been curious about the shape of dogs' hind legs. For example, I wanted to know why humans had broad feet, but dogs and cats did not. Another question was, 'Why do dogs and cats have knees that stick out backward?' At the time, I was told that my questions were silly, but I actually sometimes get the same questions from my students today, so I guess the 'mystery of the hind leg' is a common curiosity people have.

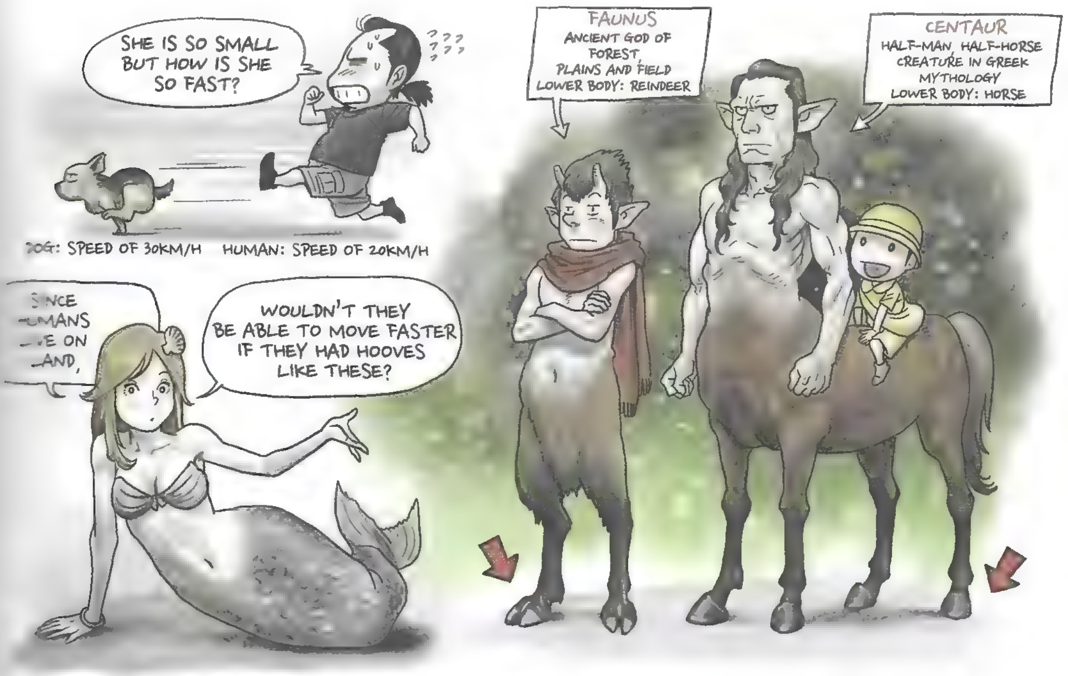
Although it took me years to realize the difference between a human leg and a dog's hind legs the explanation was quite simple. If you compare the bone structures, human legs and dog hind legs look very similar, but they are different lengths. After some research I learned that what I thought was the dog's knee was the dog's heel.



However, the human foot and dog paw look very different. Why do they look so different when the foot serves the same function? It's understandable why the human hand is shaped differently from animal hands, because they serve different functions, but why does the foot need to be different when its only function is to move?



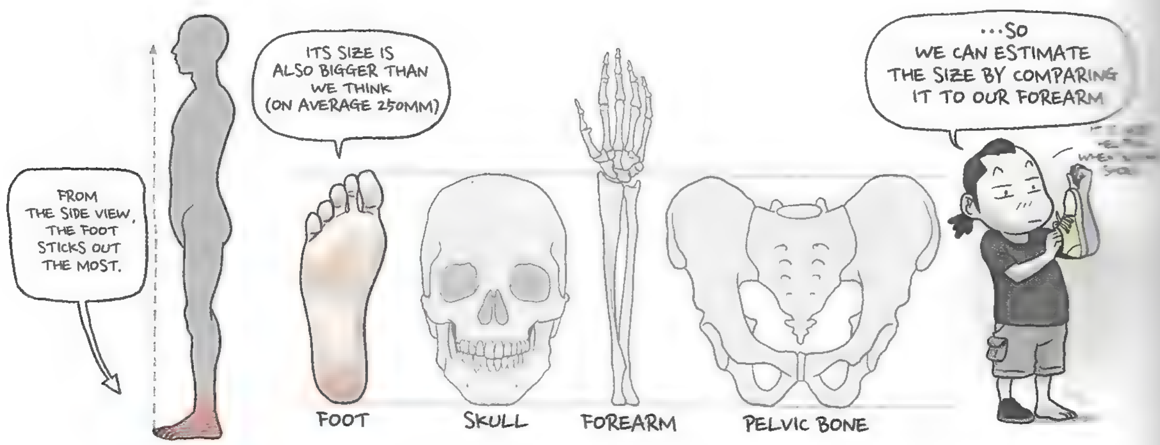
For instance, dogs are smaller than humans but faster. Then why didn't humans develop feet like that of dogs? In other words, wouldn't it be more advantageous for human survival to have feet that allow greater speed? Like those half-human half-animal creatures from Greek mythology. To answer this question, we will have to compare the human foot to that of other animals.



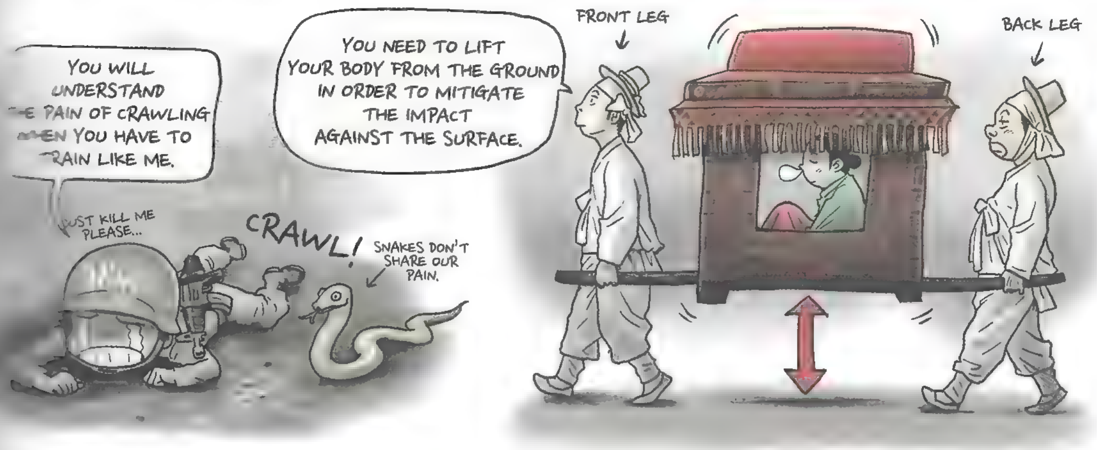
■Standing on Two Feet

From here on we will revisit the concept of our feet and to do that, we should clarify its 'role' first. Let's make it simple. Why do we need feet?

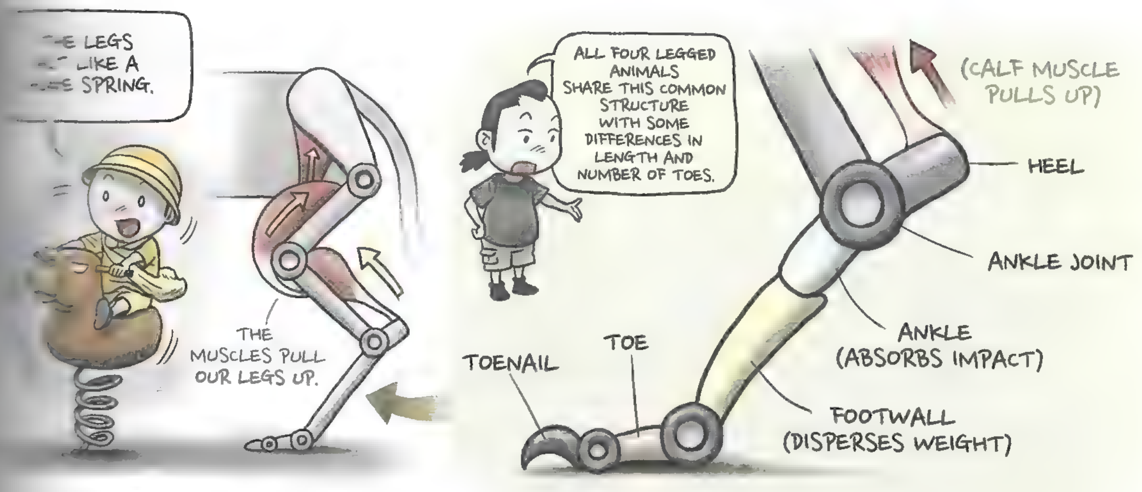
There are many reasons we could give for 'why feet exist,' but the most obvious answer is that it enables us to stand. If we observe our body, the space our feet take on the ground is long and wide. This shows how our feet play the biggest role in enabling us to stand.



The act of *standing* is very important for terrestrial animals because they need to lift up their bodies against gravity. The surface of the land is rough and jagged with many harmful insects and bacteria. While snakes can slide over surfaces with their scales, humans skin and organs would be damaged if they had to crawl across land.



In order to move effortlessly over the surface and to minimize impact to the body, all four legged animals on land share a common structure. The structure is one that can effectively hold up a heavy body for a long period of time.

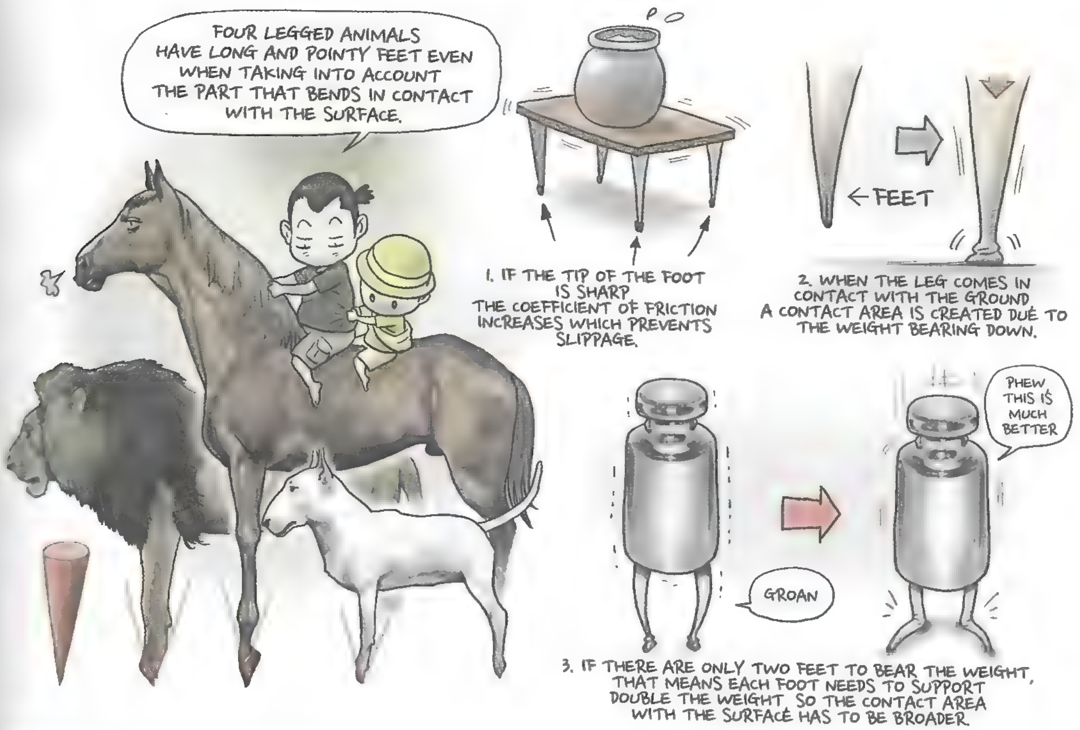


Being erect, or walking on two feet, is yet again different to 'standing.' We take for granted the fact that we can stand, but for vertebrates, standing erect is not the most recommended position because of the many risks the position entails.

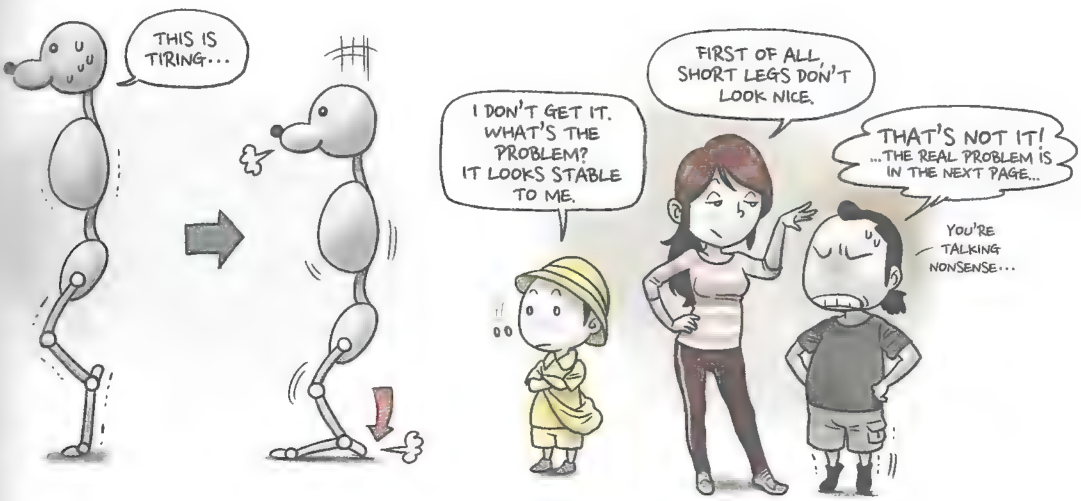
Even if I don't list out all the reasons, we can deduce that standing erect is an awkward and inefficient position when we think about how many animals do it. Humans evolved to stand on two feet not because they are lord of all creation but because they had to despite all the dangers.

In addition to the above reasons, an upright body decreases exposure to direct sunlight compared to four legged animals, so it is effective in cooling the body temperature (approximately 33%).

Anyways, since humans evolved to stand upright, human feet adapted accordingly. In general, four-legged animals' feet are pointed in order to maximize friction with the surface, but human feet evolved to become long and flat because it only has two feet to support a person's body weight.



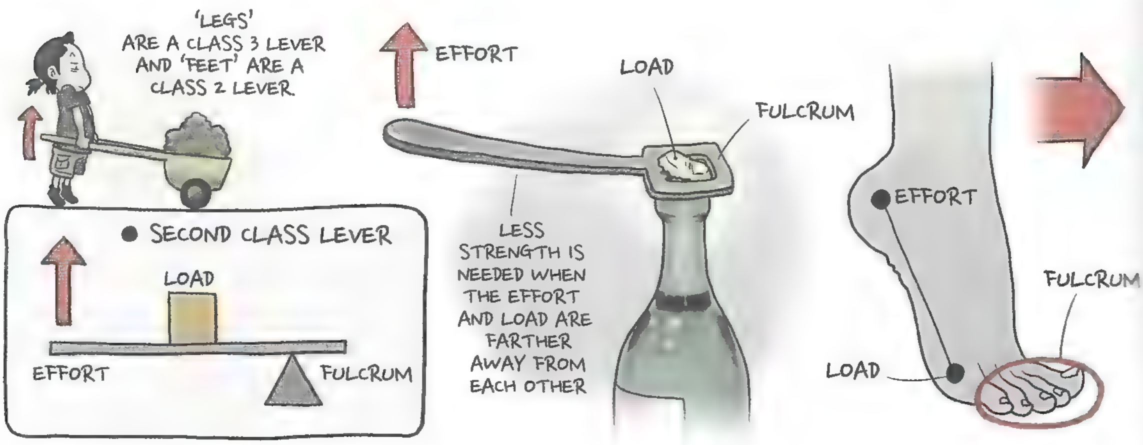
To sum up, humans needed feet with a larger surface area to support the weight of their body, and as their feet grew their legs shortened. This led to another problem because short legs have a fatal vulnerability. Survival became more complex.



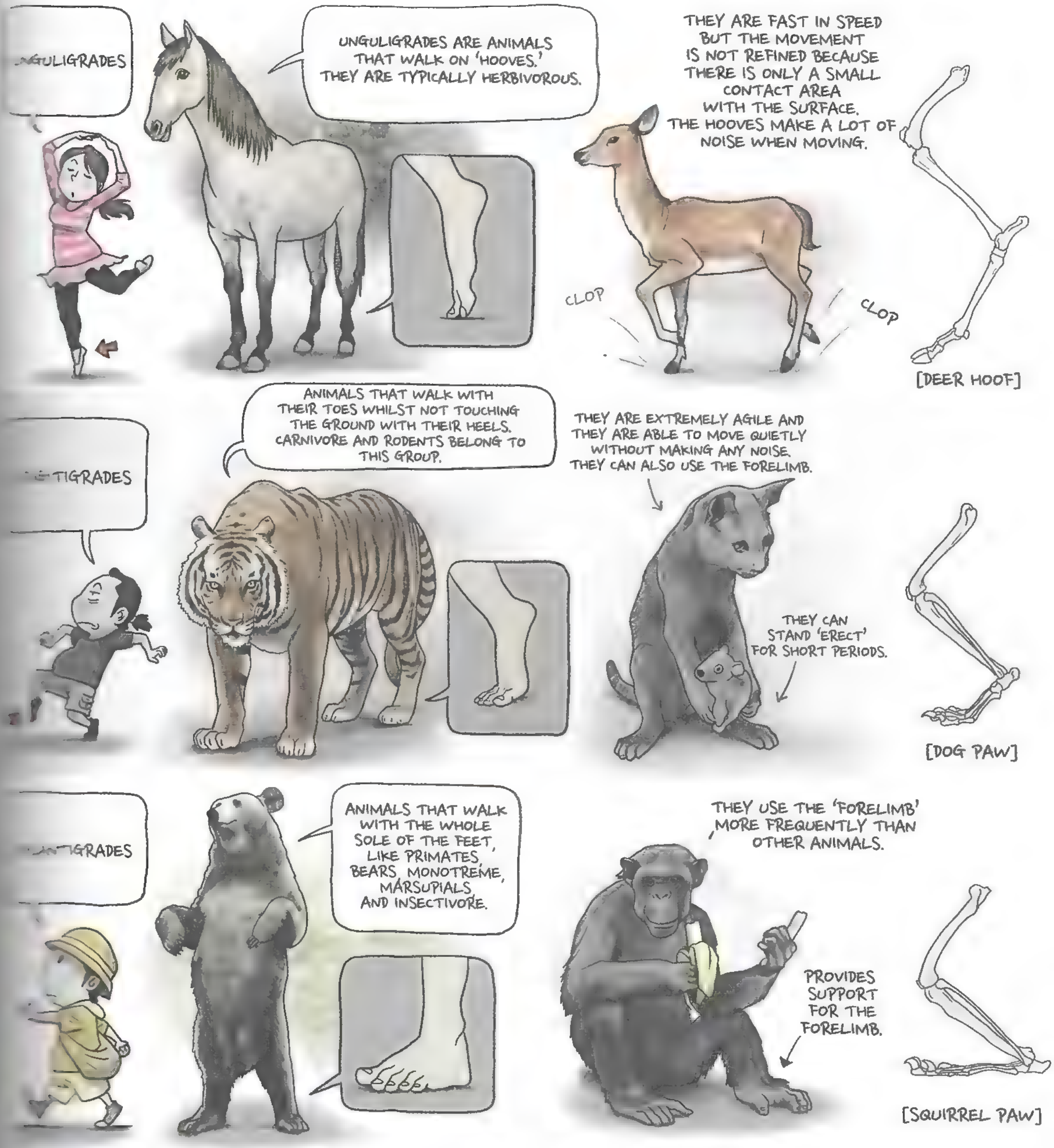
■How Foot Length Affects Speed

This time, let's think about feet in terms of movement. For survival purposes, it is more advantageous to move faster than other life forms. So, what foot shape would help terrestrial animals move faster?

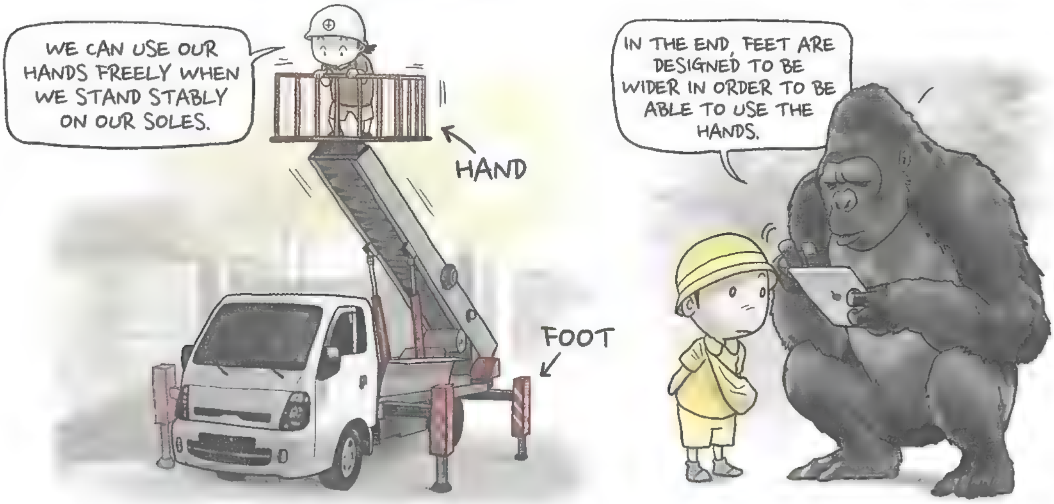
That's right. In order to move faster, the feet must be 'long.' One can run faster if the length of the surface in which the foot comes into contact is longer. Let's briefly revisit the 'law of lever' we studied earlier. The foot structure is a class two lever. If the distance between the effort and the load is bigger, less strength is needed to push off the ground, which means that you can run faster.



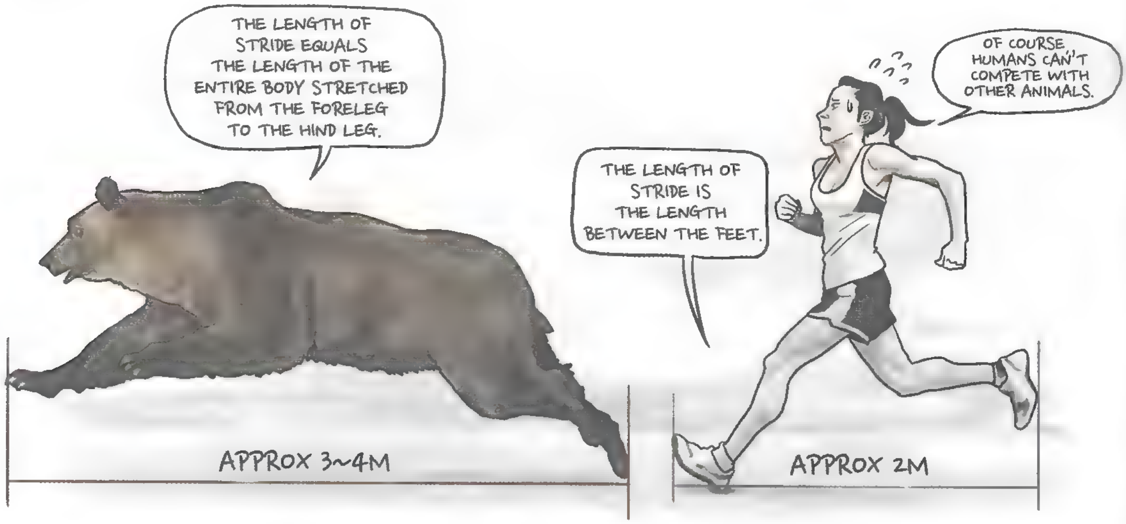
Therefore, for animals to run fast, the length of the fulcrum should be as short as possible while the length between effort and load should be as long as possible. Simply put, the smaller the foot, or contact area with the ground, the faster animals can run. In the end, the key lies in what proportion of the leg length is used as a foot. There are three forms of locomotion used by terrestrial mammals.



To summarize, the speed of animals depends on how little contact area their feet have with the surface. In the order of unguligrades (toenail), digitigrades (toe) and plantigrades (sole), the feet become longer, and the speed becomes slower. The interesting thing is that the use of 'a foreleg' is inversely proportionate to speed. In other words, the more the 'foreleg' is used for different functions, the shorter the length of the entire leg becomes, and slower the speed. This is thought to happen because as the 'foreleg' has a more varied purpose, the hind leg will have to support the upper body that holds the forelegs

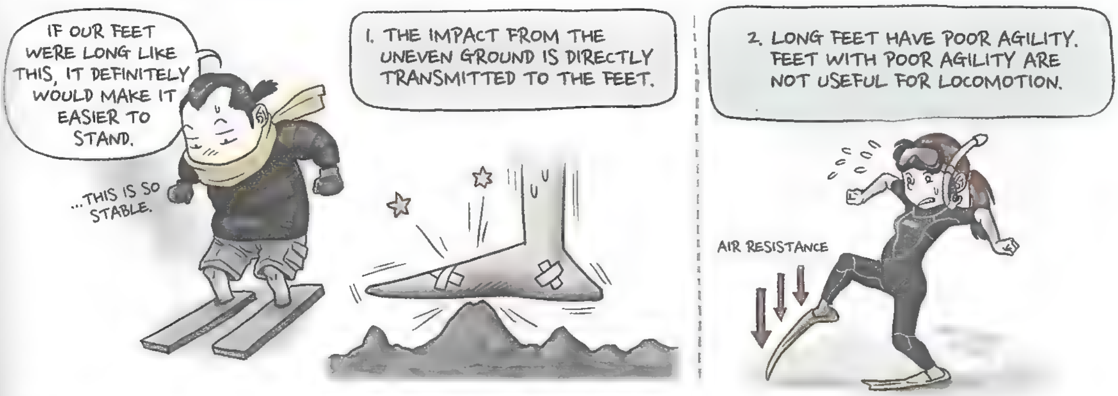


Humans obviously belong to the 'plantigrade' species because they need to use their 'hands' (foreleg). However, humans are slowest among plantigrade species such as bears and gorillas because other animals can use all four legs to move faster, but humans only have two legs for moving.

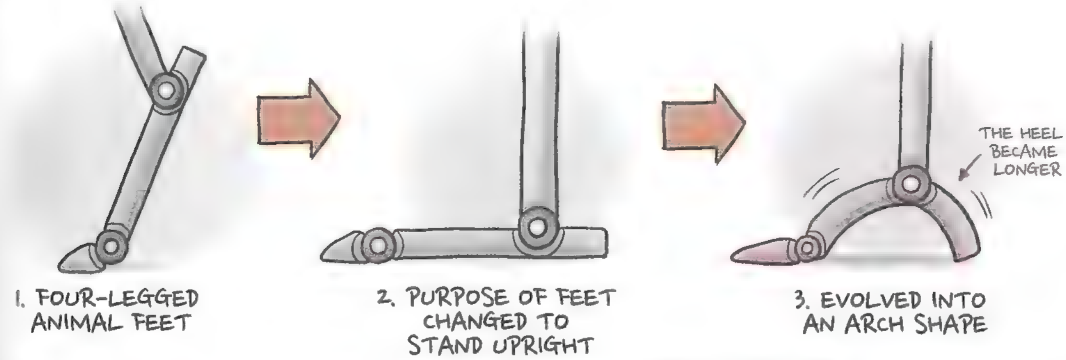


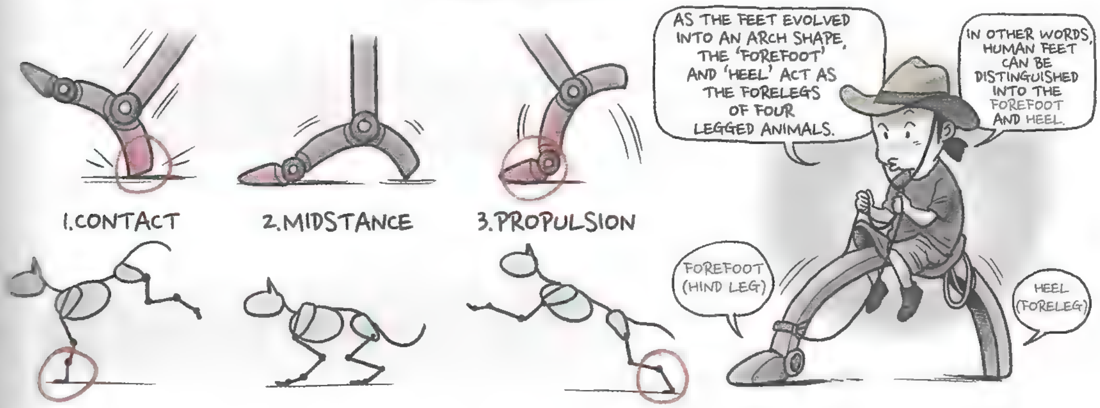
Bears and gorillas are plantigrade animals, but they use their 'toes' when running on all four legs, and this makes them much faster. That is why some hunters say that if one ever comes across a bear in the forest one should not bother to run because humans cannot outrun bears.

To make things worse, our feet evolved to have greater contact with the ground surface in order to support the upper body weight, but long feet actually have a big disadvantage because they are not suitable for locomotion. Long feet enable humans to stand but are not useful for moving. On the other hand, having short feet would enable humans to move better, but would make it difficult to stand. What a contradiction!

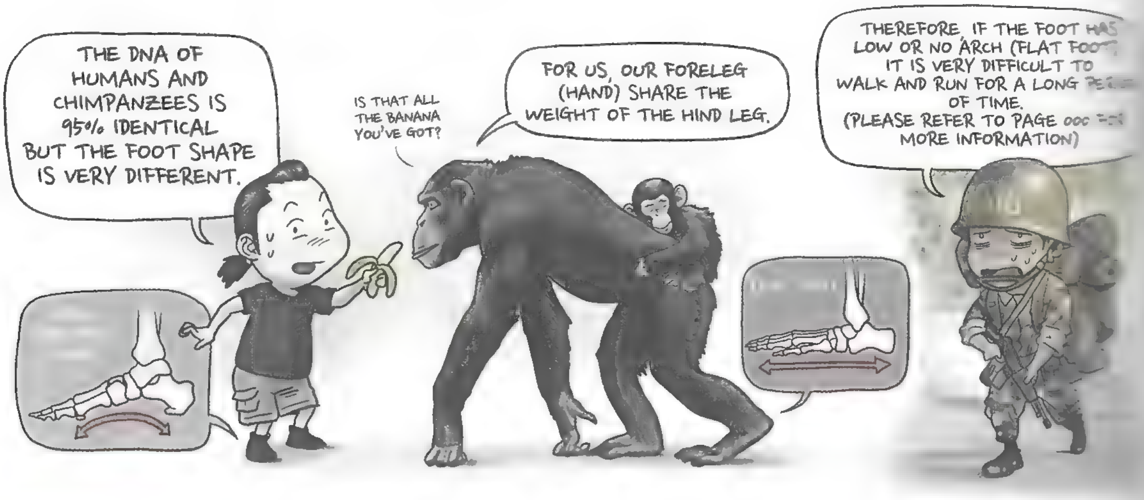


This poses a big problem. How are humans supposed to move if their feet are not suitable for moving? But, not to worry. Human feet have evolved transformed from a flat shape to an arched shape. The structural advantage allowed humans to move faster, albeit not at the speed of four-legged animals.





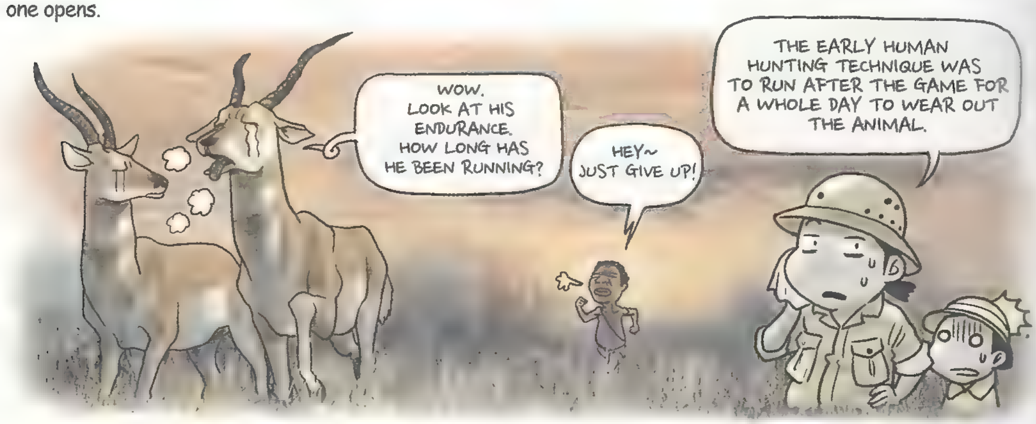
Human feet transformed from a flat shape to an arch shape to meet both the needs to stand in an erect posture and to move. It was a perfect transformation. Thanks to the arch, our feet can support the weight of the upper body which takes up to 70% of a body's weight and holds it in an erect posture, allowing it to move comfortably.



wait! The secret to long distance running

We can't do anything about the fact that humans are slower than four legged animals, but humans have the ability to run long-distances. Unlike other animals that control their body temperature solely by breathing humans can efficiently lower their body temperatures by sweating. This is because they have developed sweat glands and they have less body hair. This enables us to run longer than other animals.

In other words, humans are less agile but they have greater endurance because of the bodyweight they must support for long periods of time. It's difficult to conclude which ability is better but the human ability for endurance is definitely an advantage they can use to compete with other animals. When one door closes, another one opens.

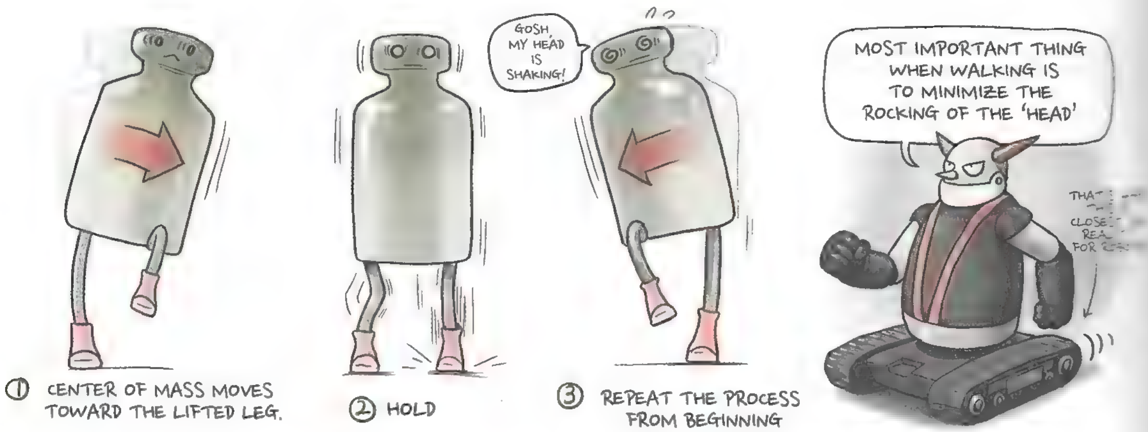


■Foot, Walk the Steps

The arch shape provided the minimum condition for human feet to be able to stand erect and move simultaneously. This should be enough for humans to walk, so let's try walking.

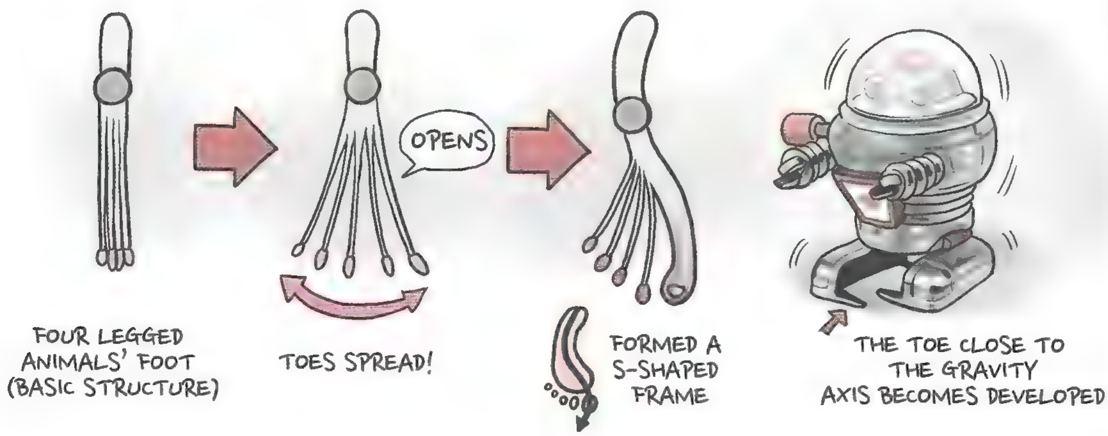
I was afraid this might happen. It is no easy task. Moving slowly or walking is trickier than running. Of course, if we consider the weight that our feet must endure while running, running seems more arduous, but when we walk slowly our feet must handle the burden of balancing the entire body.

To walk with only two legs, our feet must take turns balancing the body. That means the body weight will lean from side to side repeatedly, making the upper body sway. This is not good for the control tower located on top, and it burdens the body overall. That is why it is difficult to create a bipedal walking robot.

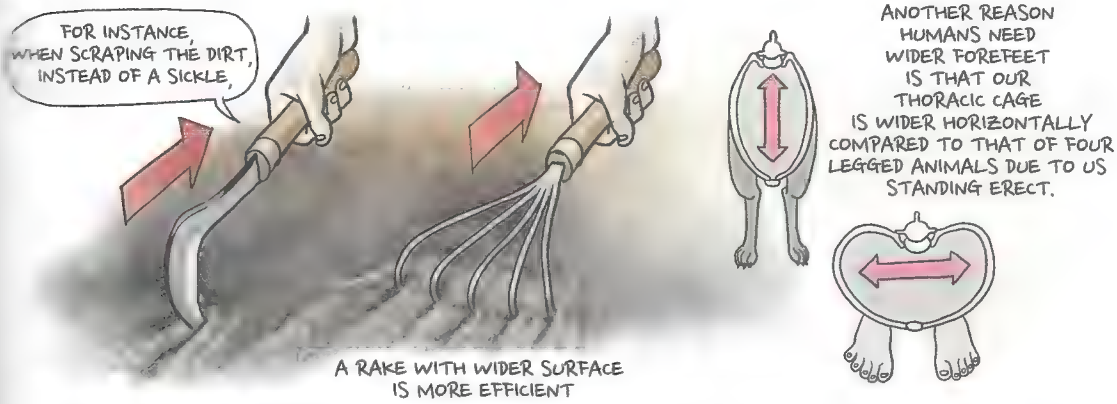


Of course, our body is not designed to allow the head to shake like this. The pelvis, spinal column and muscles balance the body when walking. That is why 'walking' is exercise for the whole body.

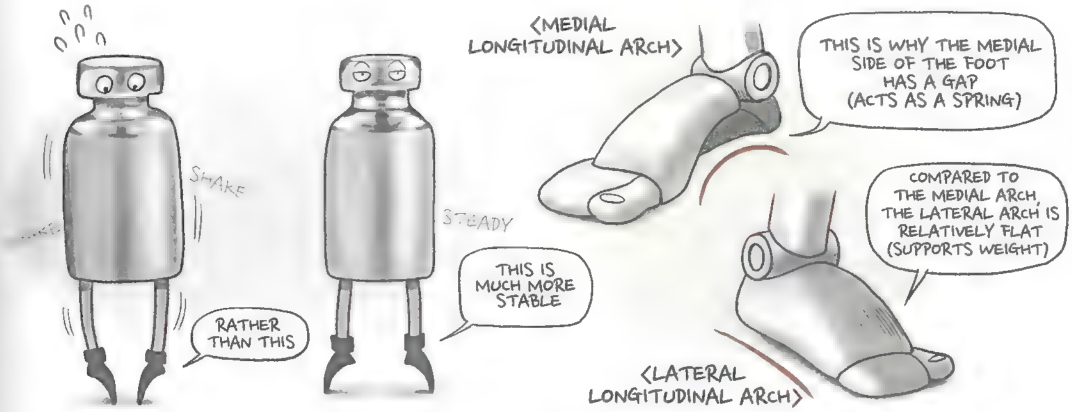
For this reason, the foot evolved to become wider so one foot could support the weight and balance. When humans walk, more weight is put on the big toe which is closer to the center of the body. As a result, the big toes developed accordingly and ultimately the inside of the foot shape became a high-arched S shape. As a result, it becomes easier to balance the body while maintaining the arch of the foot.

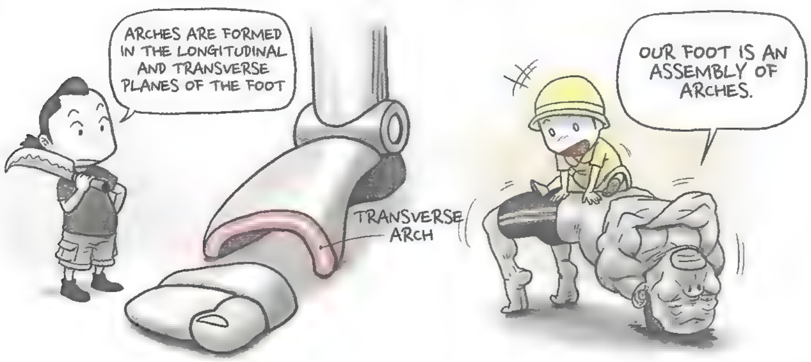


A wider forefoot means there is greater contact with the ground and this is advantageous when the body needs forward propulsion.To emphasize once again, Humans must move while supporting their heavy weight with only their two feet.

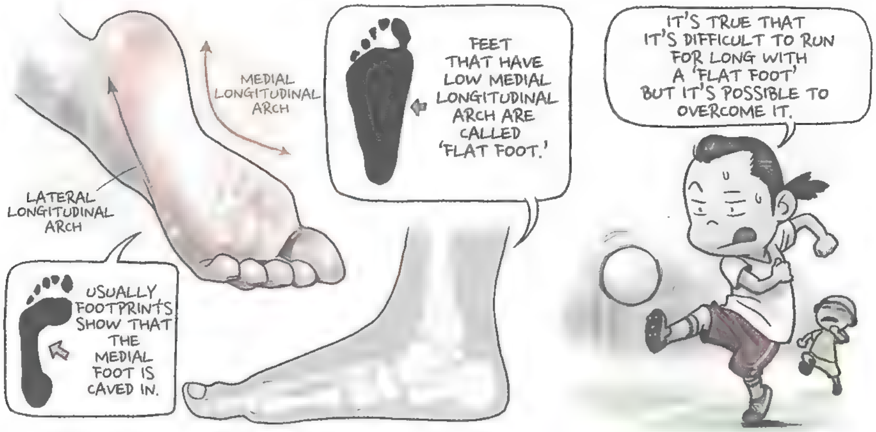


But, when standing still, the outside of the foot is better suited to balancing the body than the medial side of the foot. As a result, the foot has a unique appearance where the medial of the foot is caved in and the lateral side is flat. In addition, the transverse cross section of foot shows that the top of the foot is an arch shape just like the longitudinal view.





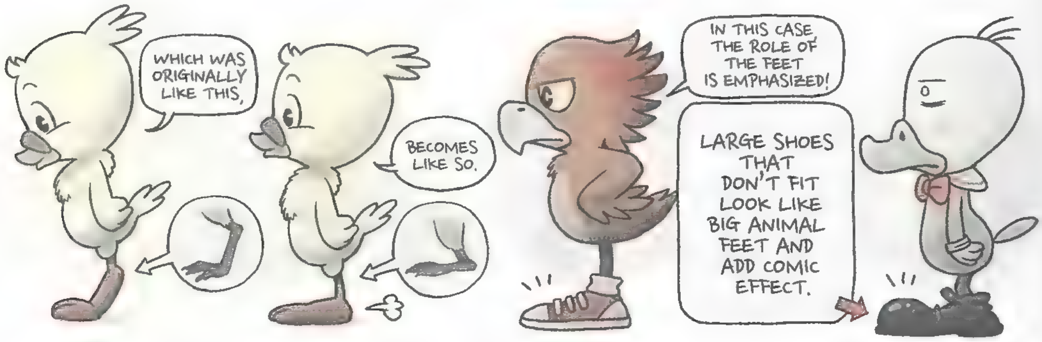
Because the foot has both longitudinal and anterior transverse arches, the middle of the sole is caved in. Sometimes, these arches are low. When the 'medial longitudinal arch' is low, we call such foot a 'flat foot.' It is difficult for someone who has flat feet to walk or run for long periods of time as the feet can't absorb the impact coming from the weight.



This is all we need to know about the foot for now. There is a lot more to learn about the structure of the foot but I think we gained enough knowledge to be able to study the bone structure of the foot. Now, let's look at the actual shape of the foot.

Wait! Feet of Animation characters

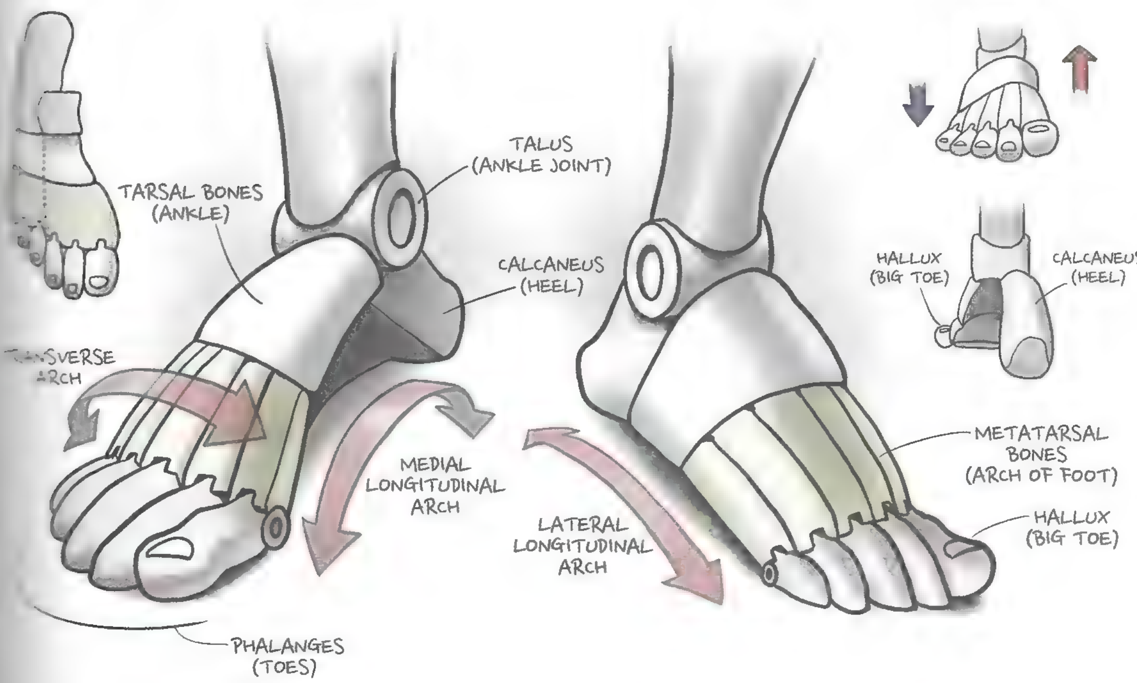
Oftentimes personified animal characters in cartoons or animations are depicted as having unnecessarily long and huge feet. As we now all know this kind of foot is inefficient when walking erect. Regardless, there are several reasons why animal characters' feet are drawn this way. First, 1. It is to emphasize the fact that animals have longer feet compared to humans. 2. It is used as a stage tool to add humor 3. It is used to visually emphasize 'speed.' The point of cartoons and animations is to 'exaggerate and transform.' For that end, drawing the feet in this way is a very effective way of depicting animation characters.



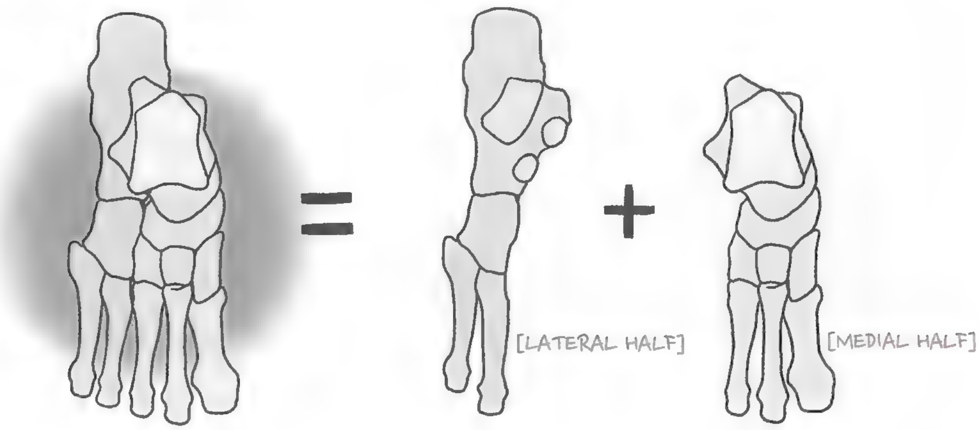
■Categorizing the Skeleton of the Foot

Since hands were originally 'feet,' the bones of the hands and feet are similar in number and role. But as I mentioned earlier, because the role of feet is much simpler than that of hands, you will be able to master this section easily if you've studied your hands well.

However, the actual skeleton is still very complicated. To simplify things, it is important to figure out the bones of the foot by its shape and function. There are various ways to categorize the bones of the foot but 'shape classification' is most common ①Tarsal bone, ②Metatarsal bone, ③Phalanges just like our hands. Doesn't it look similar to our lesson on hands?

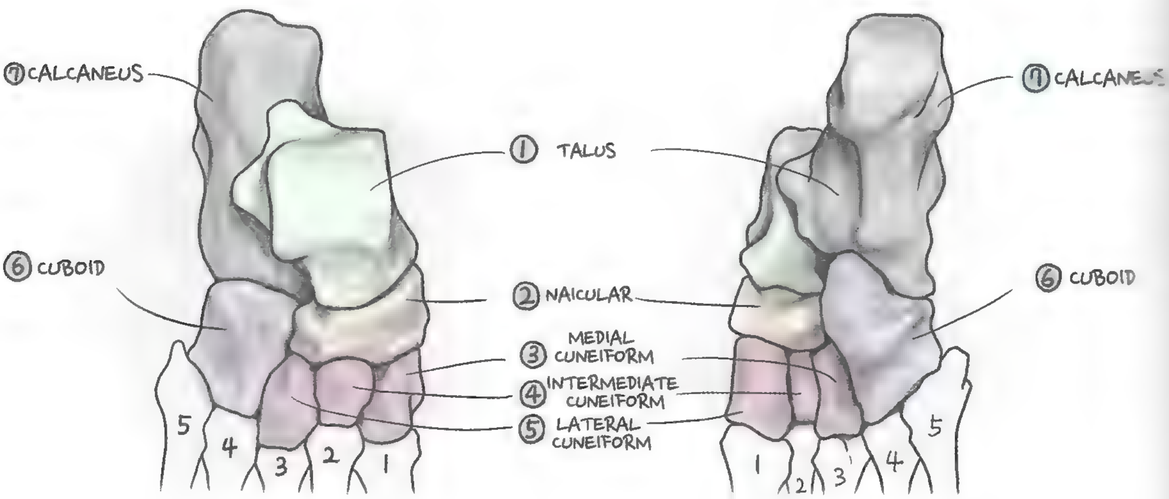


Another way to categorize the bones of the foot is by its function. You can divide it into 'medial half' which disperses the weight like a spring and 'lateral half' which supports the weight.



❶ Tarsal bones

The tarsal bones link the lower leg and the foot. These bones substantially function to bear the weight like ridgepoles. The tarsal bones are called the 'root of foot' although they are located on top of the foot and it is the starting point of the foot. In terms of hands, it is where 'carpus' is but the tarsal bones of foot makes up half of the entire foot. It has a slight unique movement compared to the carpus in the hand that has almost no movement. Let's first look at the names of each tarsal bone.

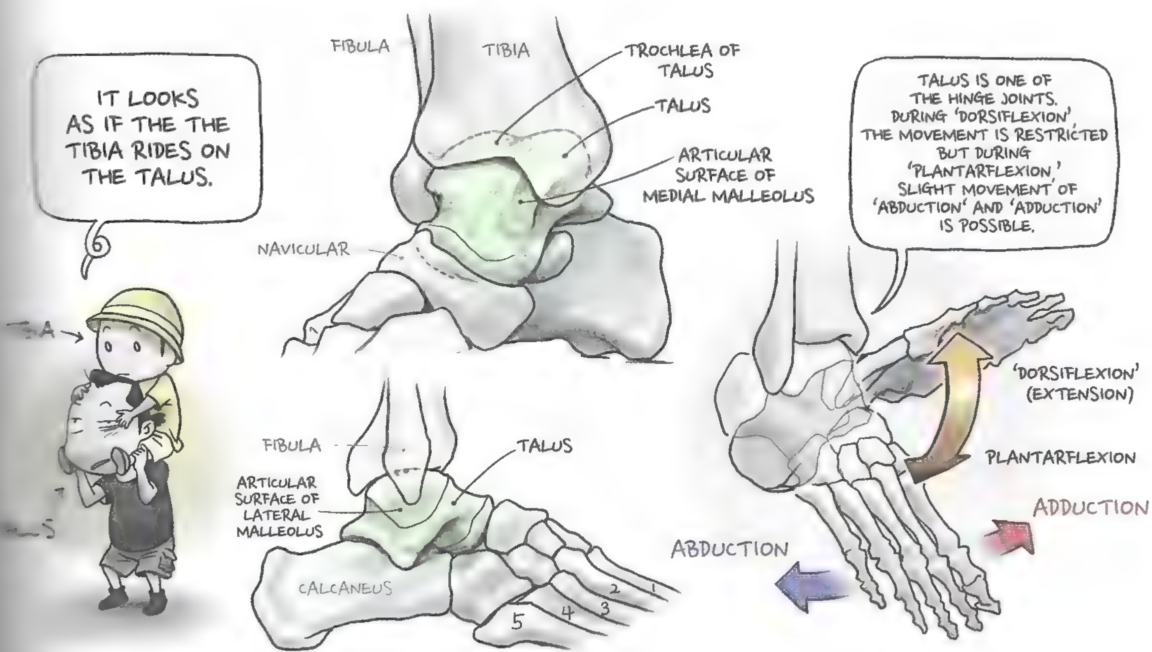


- ❶ **Talus : T**
- ❷ **Navicular bone : N**
- ❸ **Medial cuneiform bone : Cun1**
- ❹ **Intermediate cuneiform bone : Cun2**
- ❺ **Lateral cuneiform bone : Cun3**
- ❻ **Cuboid bone : Cub**
- ❼ **Calcaneus : C**

The order is in clockwise rotation starting from 'talus' which is directly connected to the tibia and fibula (based on top view of foot bones). The tarsus consists of seven bones and even though it looks like one lump, each of the bones has its own functionality and shape. You should pay special attention to two bones in the tarsal bone category the talus and calcaneus.

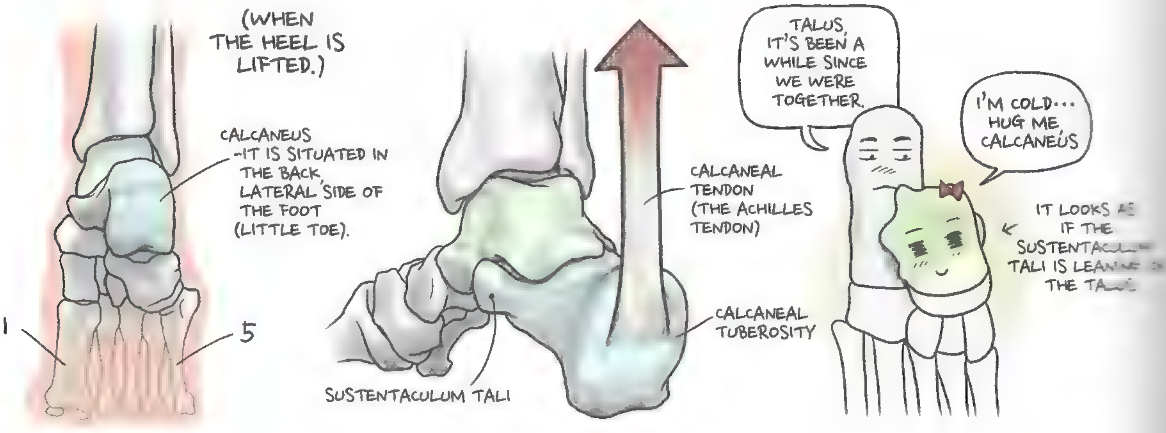
Talus

The talus articulates in conjunction with the lateral and medial malleoli of the tibia and fibula. Dorsifexion and plantarlexion, as well as a slight inversion and eversion of the foot (refer to 548 page).



Calcaneus

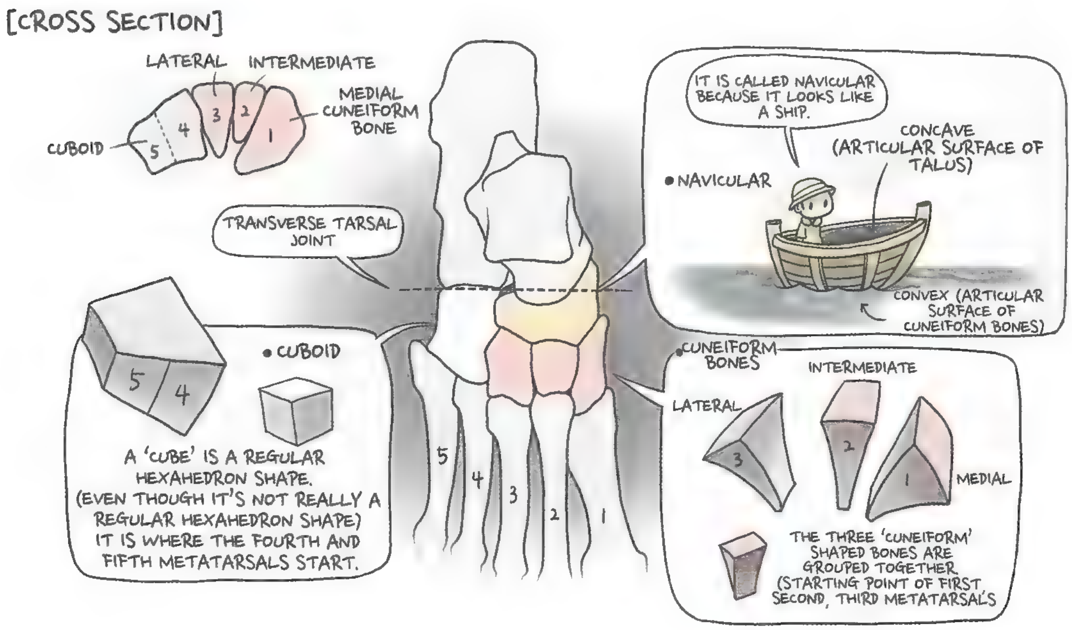
Calcaneus is the part we call the 'heel.' It directly supports a large portion of the body's weight but it also plays a crucial role in aiding walking because this is where tendons (the Achilles tendon) are attached. The Achilles tendon lifts up the heel from the surface and helps it to push off the ground. Take note that the calcaneus is located on the 'lateral' side, rather than at the center of the foot.



That's why the outside part of the heel on the shoes lands on the ground first.

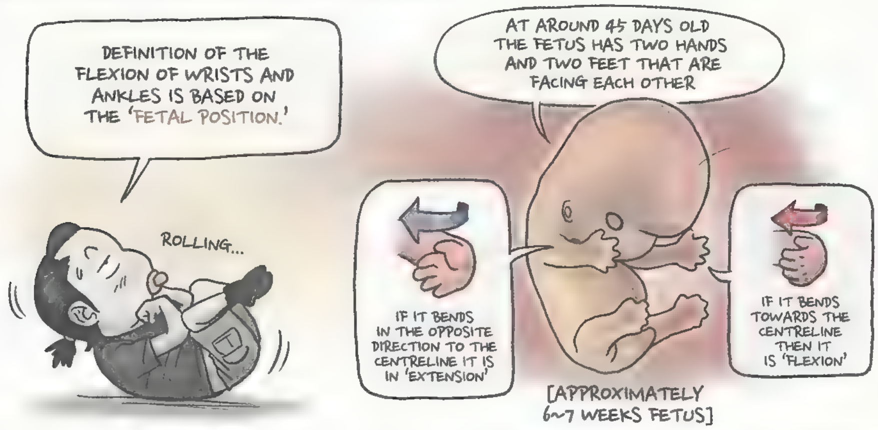
The Remaining Bones

Other than the talus and calcaneus that take up the biggest portion of the tarsal bones, the other five bones work to disperse and support body weight and to control metatarsal bones where the toes start. It is not as difficult to memorize these names because they were named after their unique figures.

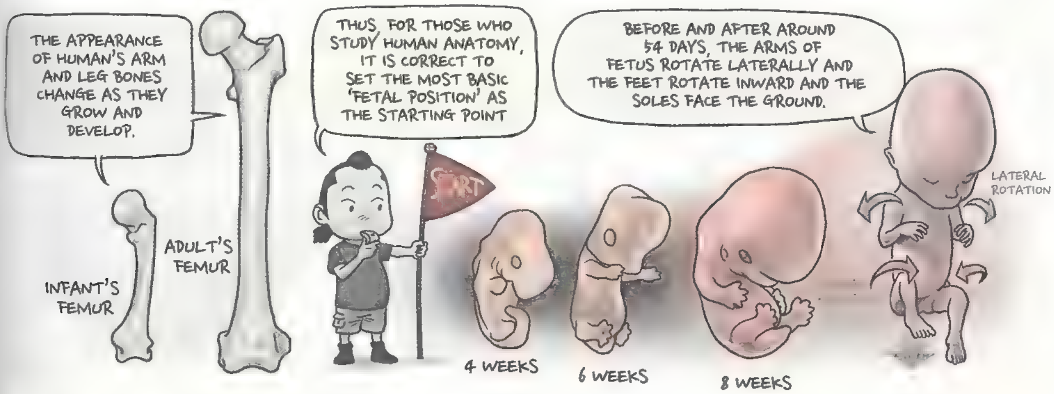


Wait! Dorsiflexion? Extension?

On the previous page, when I described the movement of the talus, I mentioned that pulling the foot towards the tibia is called 'dorsiflexion' and bending it away is 'plantarflexion'. You might be curious about how this name came about. They are counter movements, but why are they both referred to as 'flexion?' We studied this before based on the anatomical position. 'Extension' straightens the angle between two articulating bones, while 'flexion' brings the angle closer (refer to page 301). If this is the case, wouldn't it be simpler to refer to 'dorsiflexion' as 'flexion' and 'plantarflexion' as 'extension?'



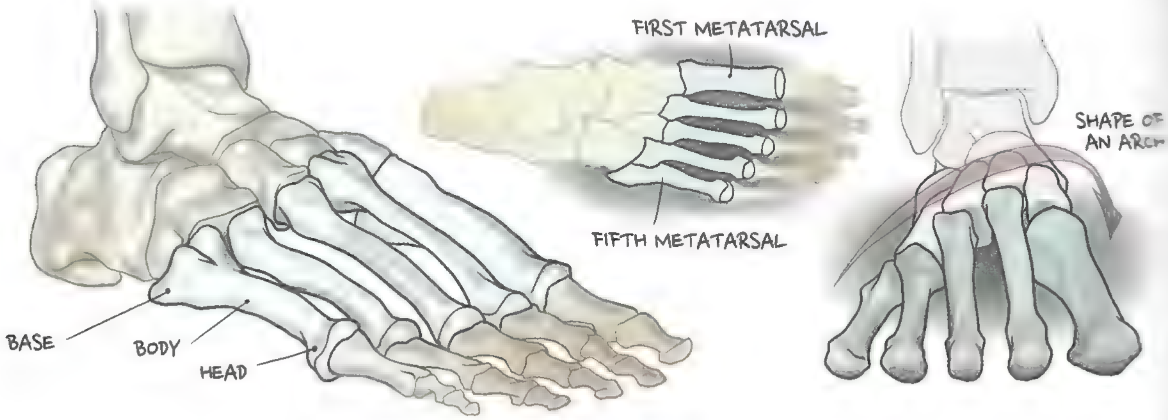
As a result, based on the 'fetal position' where the two hands and feet are facing each other, if the foot bends lateral to the centerline of body, the 'dorsiflexion' actually becomes 'extension' instead of 'flexion.' But this causes a major confusion from a general perspective of the human body after birth (I'm confused myself as I write this.) Based on common sense, when the top of the foot is pulled closer to the tibia, one would think that this is 'flexion' and not 'extension.' This is why 'flexion' is used to express the movement for both dorsiflexion and plantarflexion. Why do you think the anatomical terms of motion are based on the 'fetal position' even if this causes a lot of confusion?



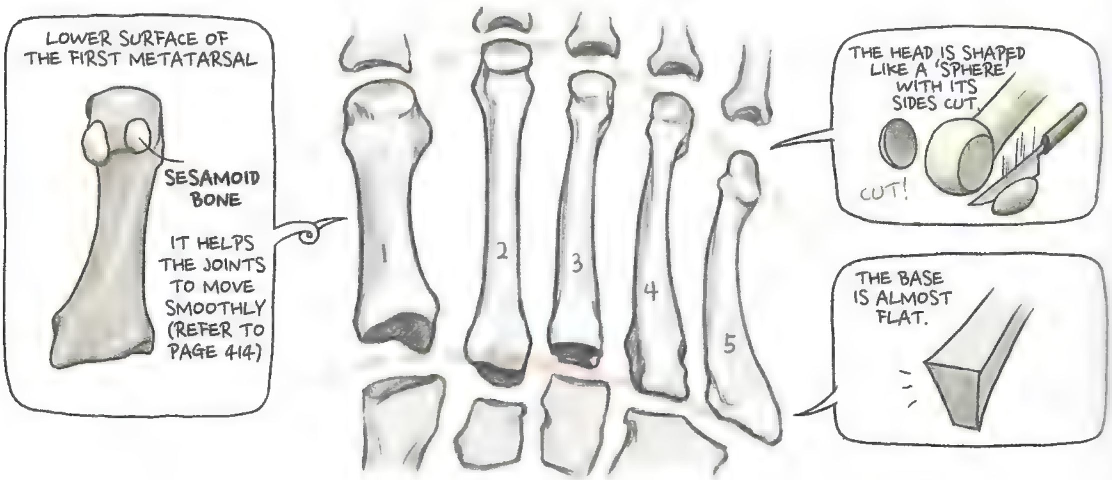
We should know that scholars who first discover a phenomenon give much thought when they come up with names. Scholars are not intentionally trying to get us confused. Therefore, it is helpful to think in the scholar's shoes sometimes, rather than being confused and memorizing when you're faced with such puzzles.

❷ Metatarsal bones

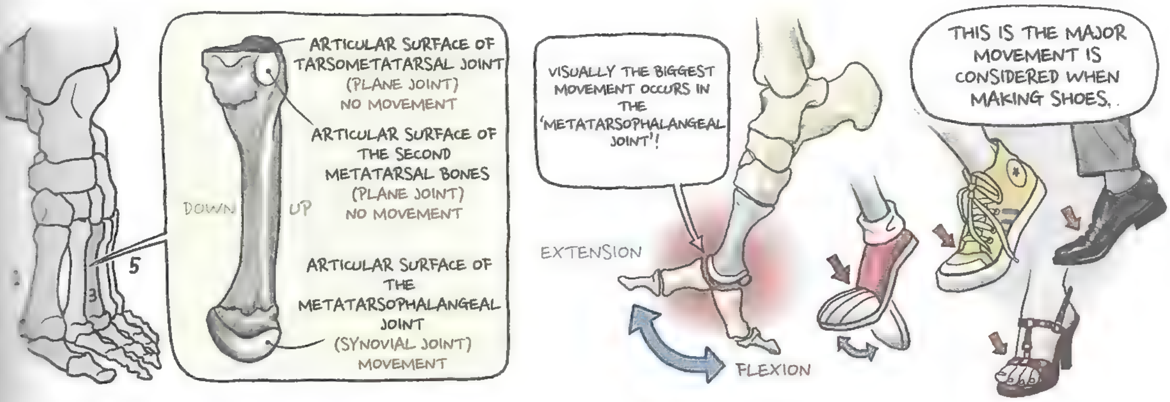
Metatarsal bones function as a bridge that connects the tarsal bones and phalanges. In order to support the body's weight, the cross section forms an arch shape and the metatarsal bones are numbered first to fifth metatarsals from the medial side (the side of the big toe) to lateral side (the side of the little toe). The part connecting the tarsal bone is known as the 'base,' the middle part the 'body' or the part connecting the phalanges to the 'head.' Hmm… sound familiar? That's right, you must think about the carpal bones we've studied earlier.



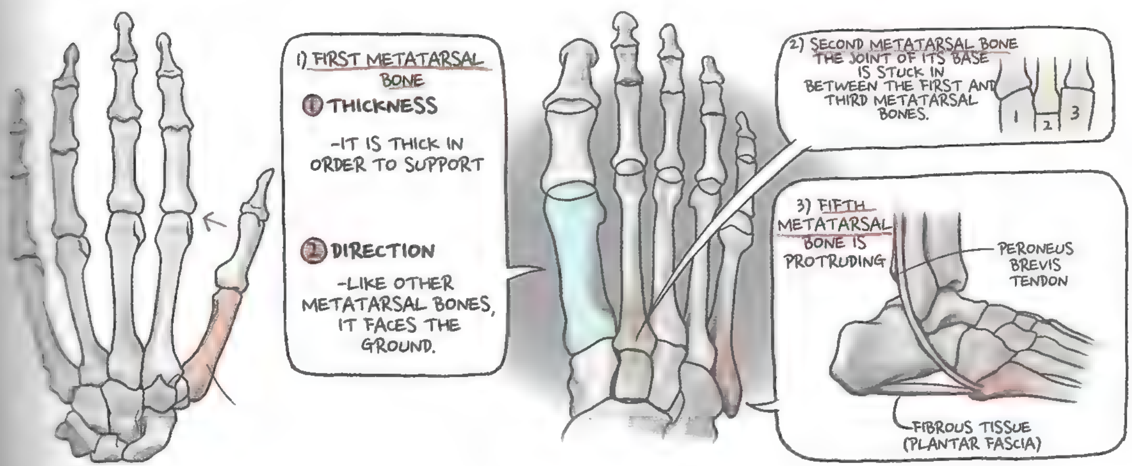
Metacarpal bones and metatarsal bones are very alike. To efficiently support the weight, individual metatarsals are bent upwards (refer to the picture above). The first (big toe) metatarsa is the shortest, and the second metatarsal is the longest bone. The existence of the 'sesamoid bone' (refer to page 414) is another shared characteristic.



Another common feature shared with the metacarpal bones is that the articular surface of the base and the head are different. Because the base is a plane joint and the head is a synovial joint, the foot's major movements occur in the head or in the metatarsophalangeal joint.



As such, metatarsal bones have many commonalities with metacarpal bones in terms of its function but there are also clear differences. (1) First, metatarsal bones are thicker, (2) the figure of second metatarsal's base is stuck between the first and third metatarsals, (3) the fifth metatarsal bone protrudes slightly laterally. Especially, as unlike the first metacarpal bone that faces all the other fingers in other to allow an 'opposition' movement, note that all metatarsal bones face the ground.

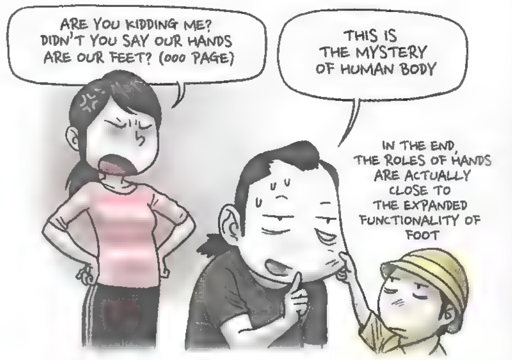


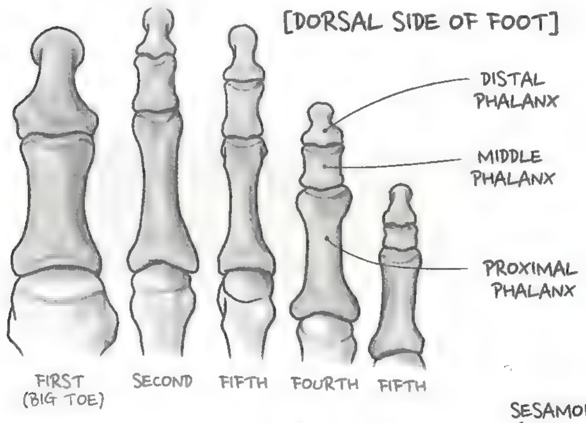
❸ Phalanges

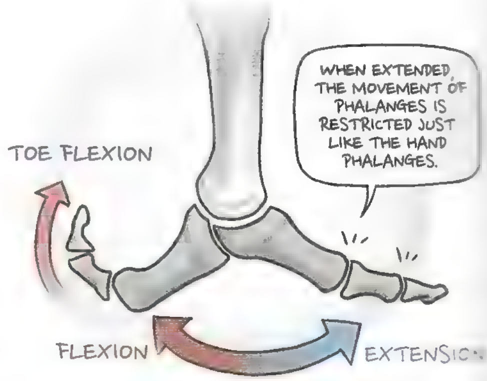
Just like metatarsal bones, toe phalanges look very much like hand phalanges.

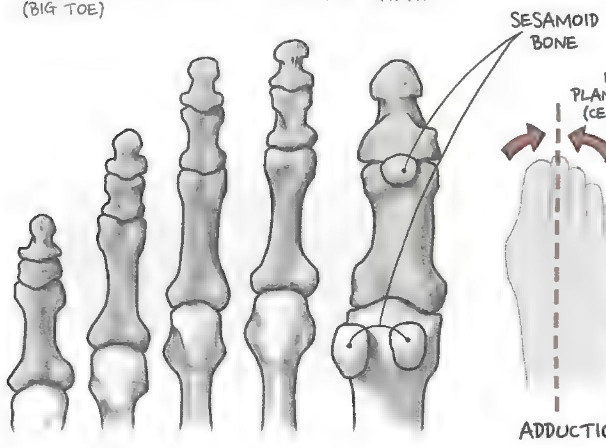
Here, we can take a guess whether the foot can grab onto things just like our hands. Unfortunately, as human feet are solely specialized for the one and only purpose of 'movement,' there's not a lot of movement that they can do on their own. However, if the foot undergoes special training or steps on the ground with added weight.

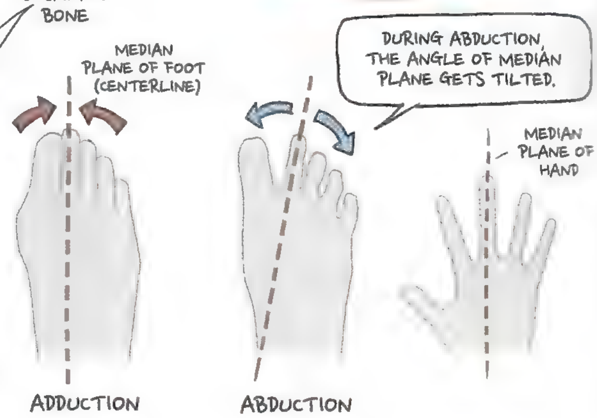
(One thing to pay special attention is that the 'golden ratio' found in hand phalanges doesn't apply to foot phalanges. Possibly because the fundamental role is different.)



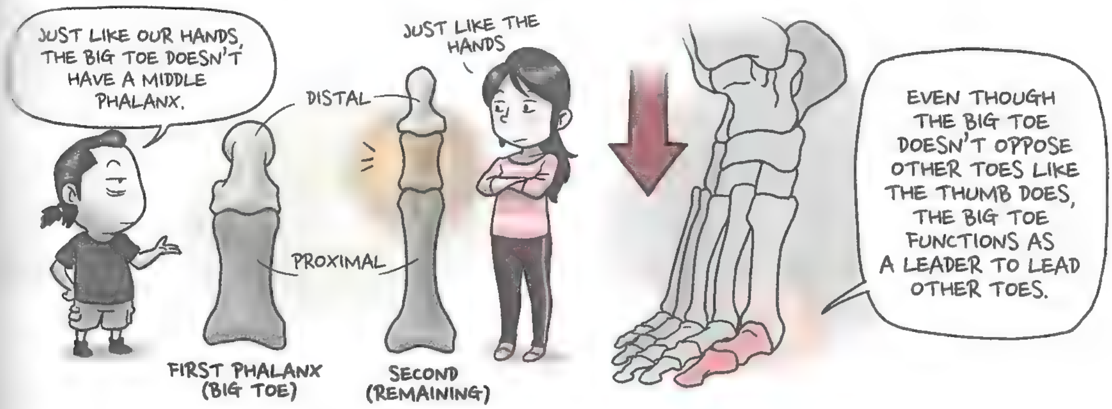






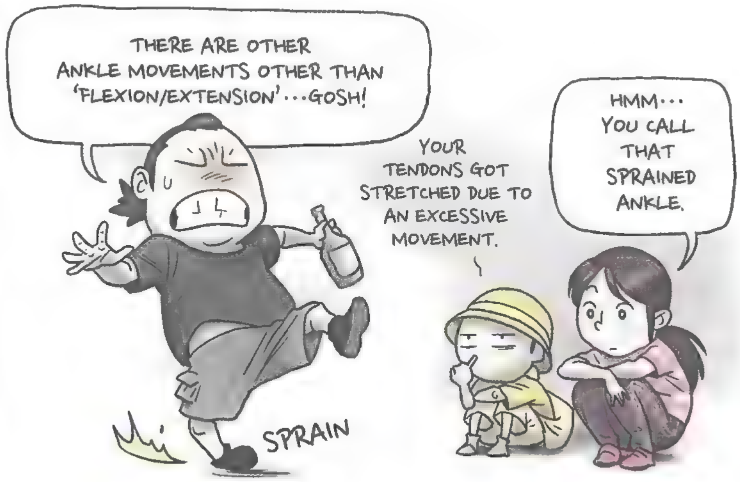


Just like the thumb, the first phalanx or the big toe consists of two phalanges - distal and proximal with no middle, and the reason is no different from that of the hands. (refer to page 404). The reason is because it requires a great amount of strength to push off the ground for walking and running.
Except, it is thicker compared to the thumb of the hand and because it faces the surface of the ground, 'opposition' movement is not possible. Therefore, toe phalanges are there to step on the ground and not to grab things.
If you are not sure about the role that your big toe plays in walking, think about the time when you hit or hurt your big toe.

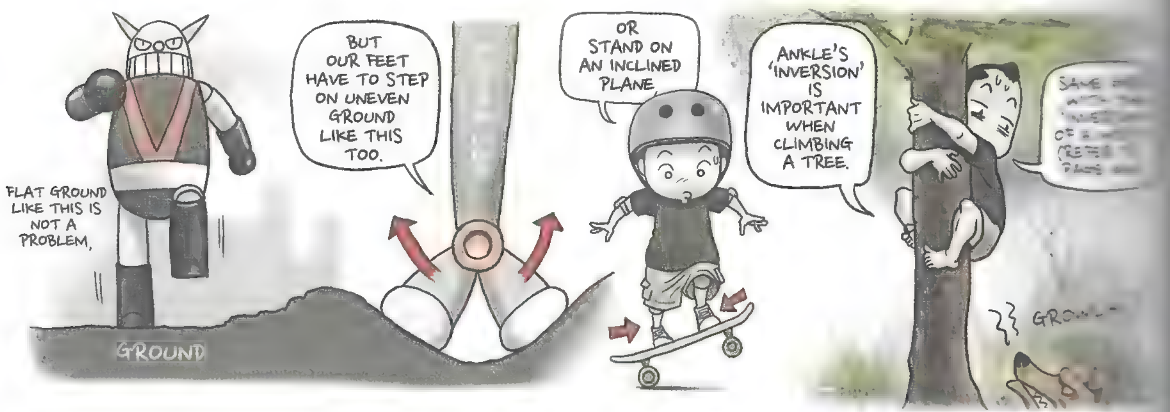


Inversion and Eversion of Ankles

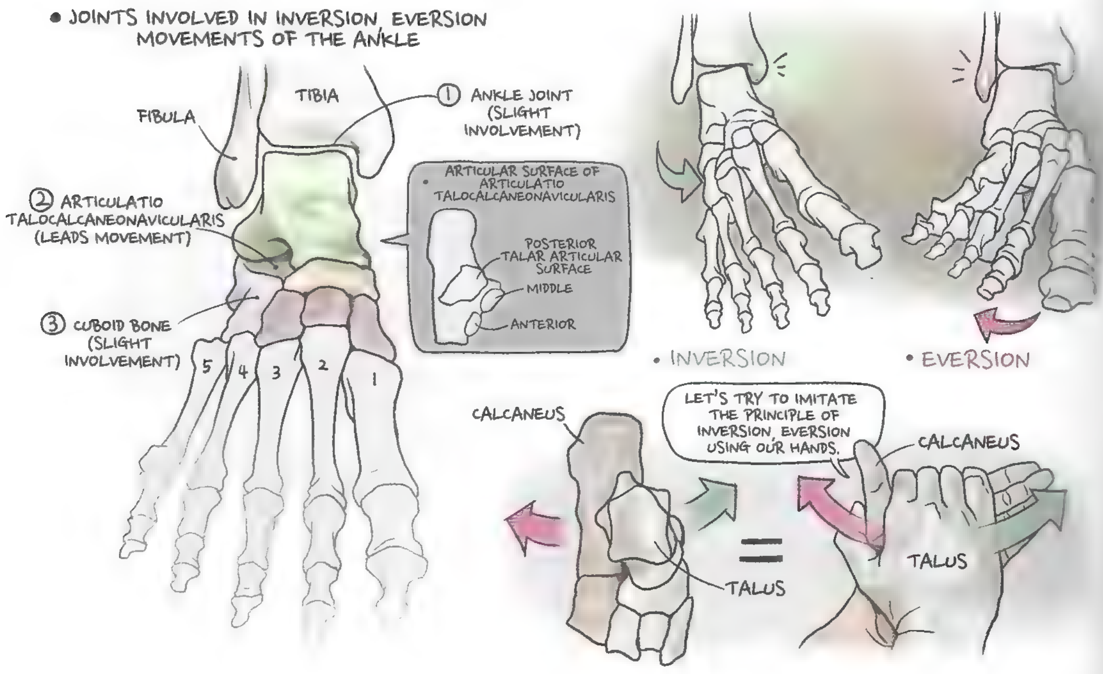
It might sound obvious but the trochlea of the talus that is directly connected to the leg and 'ankle joint' fit together perfectly like matching puzzle pieces. This allows the ankle's flexion/extension motion without getting the ankles dislocated despite its frequent movement.



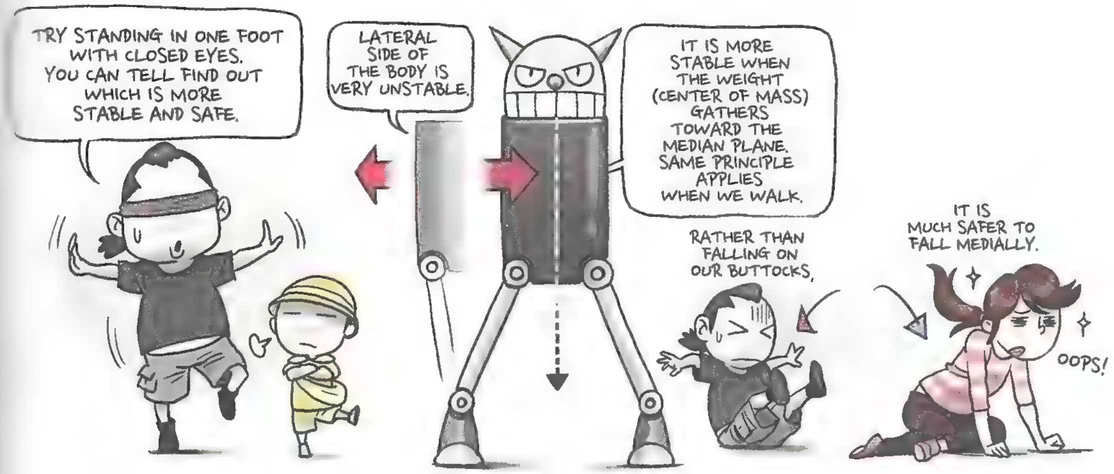
However, it is uncomfortable for humans as well as four-legged animals to walk only with flexion and extension motions. This is because the ground is not always flat. For this reason, ankle joints of an animal with long and wide feet not only have to allow up and down movements but they also have some 'sideways' movement. We call the ankles moving toward medial side 'inversion' and the ankle moving toward lateral side 'eversion.'



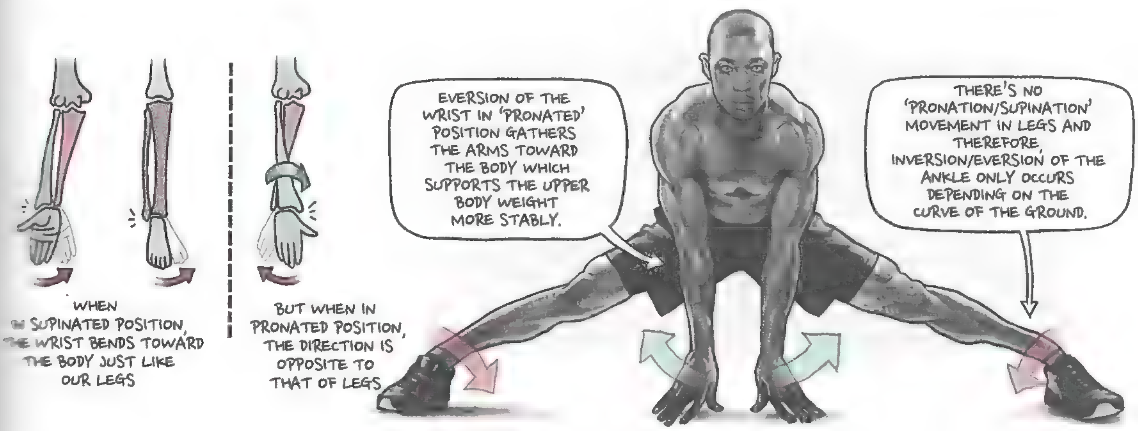
Inversion and eversion are definitely necessary movements for ankles but ankle joints cannot be solely responsible for sideways movements on top of flexion and extension. The ankle would be too burdened. That is why there are other joints below the ankle that cooperate to allow the movement. It is important to note that because the 'lateral malleolus' is lower compared to 'medial malleolus.' This makes the 'inversion' movement relatively easier than 'eversion.'



There's one question though. Why is 'inversion' easier than 'eversion?' There's no clear reason but it's certain that if there is a wider range of inversion movement, it makes it easier for us to walk with more stability as the weight leans to the median plane when our feet alternate. After all, ultimately the feet are there to 'support the body.'



An interesting fact is that the wrist is also capable of inversion, eversion movements. However, unlike the ankle, eversion occurs more easily than inversion in wrist. When we used to walk with four legs, hands and legs were both 'feet,' but because the function of foreleg (arms) and hind leg (legs) are different, naturally their inversion and eversion also differ.



Picture: example of ankle's 'inversion.'
There are differences in each martial art, but most of them intentionally cause an 'inversion' during sidekick. This results in a smaller strike point and maximizes the effect of the strike. In taekwondo, it is called 'foot blade.'

We've only learned about 'inversion/eversion' but movements occurring below the ankle are not that simple. On top of 'flexion/extension,' there's 'inversion/eversion, 'abduction/adduction' as well as 'pronation/supination' movements. Although, it is not as visible compared to the movements of the arms and hands.

Human ankles were enabled to do these subtle but complex movements, so the 'legs' could only focus on movement. It was necessary to evolve as a useful tool to adapt in various irregular environments and to functionally make up for the simple movements. To sum up, 'inversion/eversion' movements were 'developed' out of necessity.

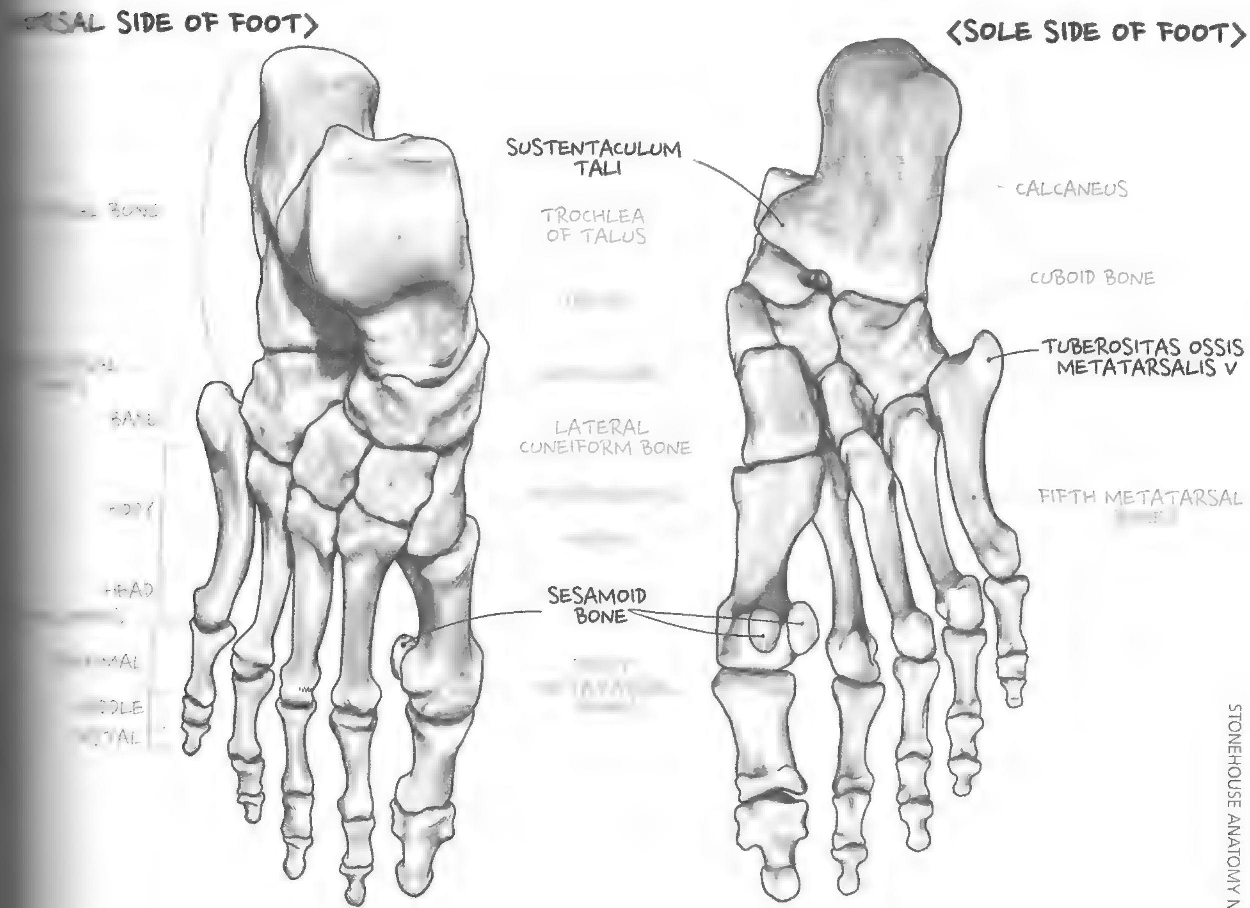
Detailed Figures and Names of Foot Skeleton

The picture on the right shows the entire skeleton of the foot and detailed names.
Since we went over most of them, let's skip the explanation and look at the rest of them.
I think it'd be nice to think about the content we've studied previously and look at it as if you're reviewing for test.

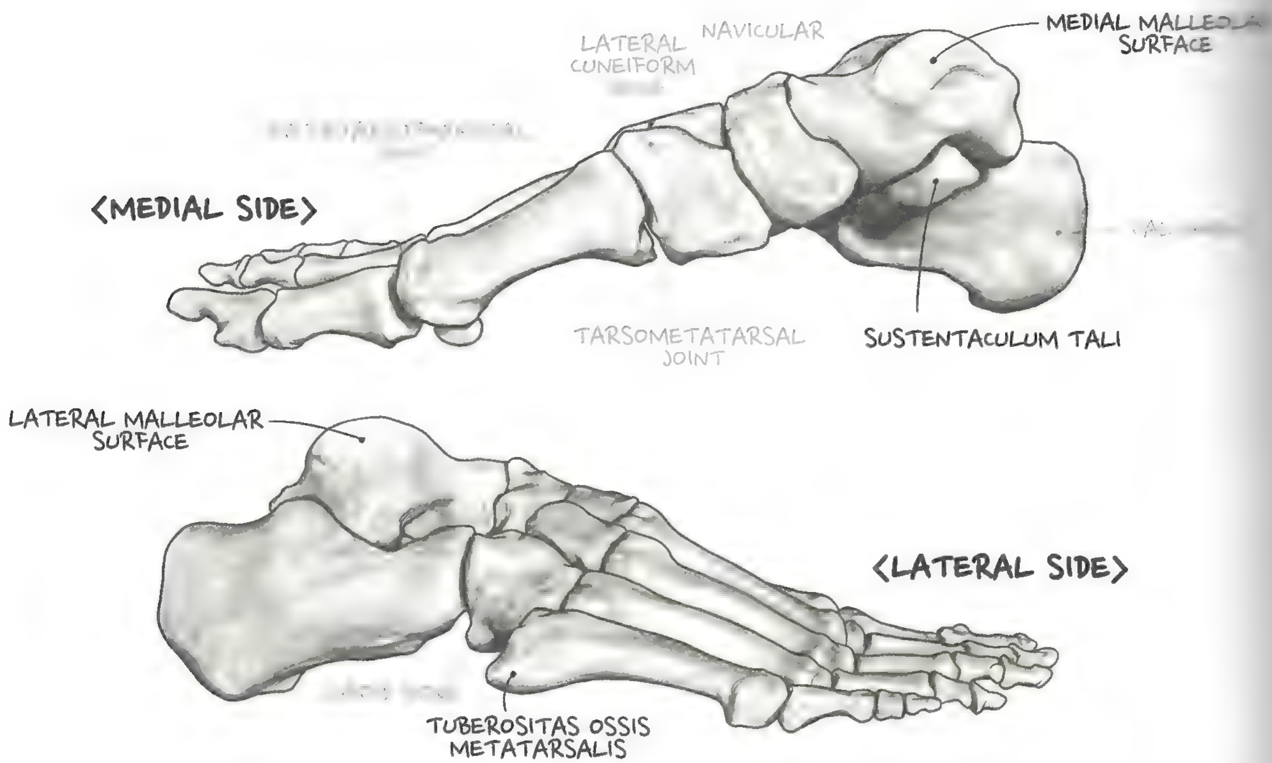
- **Sesamoid bone:** As mentioned earlier when explaining the hands and patella, sesamoid is a bone embedded in the tendon. The functions are to diminish friction between tendons and bones in order to smoothly allow flexion movements of the toes. .

- **Sustentaculum tali:** Like the name of this bone implies, it functions to support the talus. It arises from the anteromedial portion of the calcaneus. Unlike mammals that are digitigrades, humans that bear most weight on the heels put most of the weight in sustentaculum tali. It plays an important role for humans to stand erect.

- **Tuberositas ossis metatarsalis V:** It is attached to the tendon of peroneus brevis and plantar fascia found close to the sole of the foot. It is the most protruding part along the lateral plane.

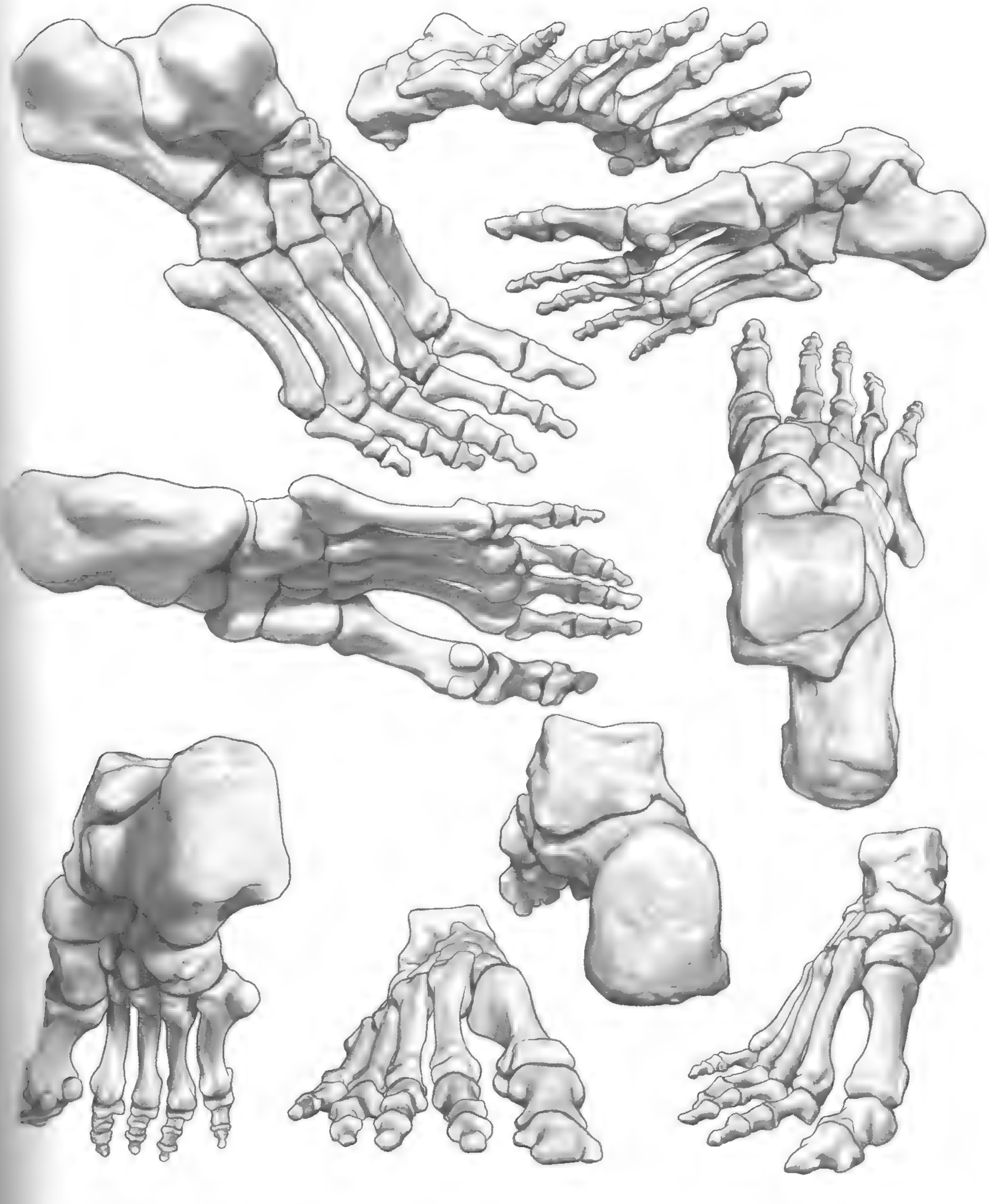


❹ Medial/Lateral malleolar surface: The medial malleolar surface articulates with the tibia and the lateral malleolar surface articulates with the lower fibula. Normally, the medial malleolar surface is 1cm higher than the lateral malleolar surface.



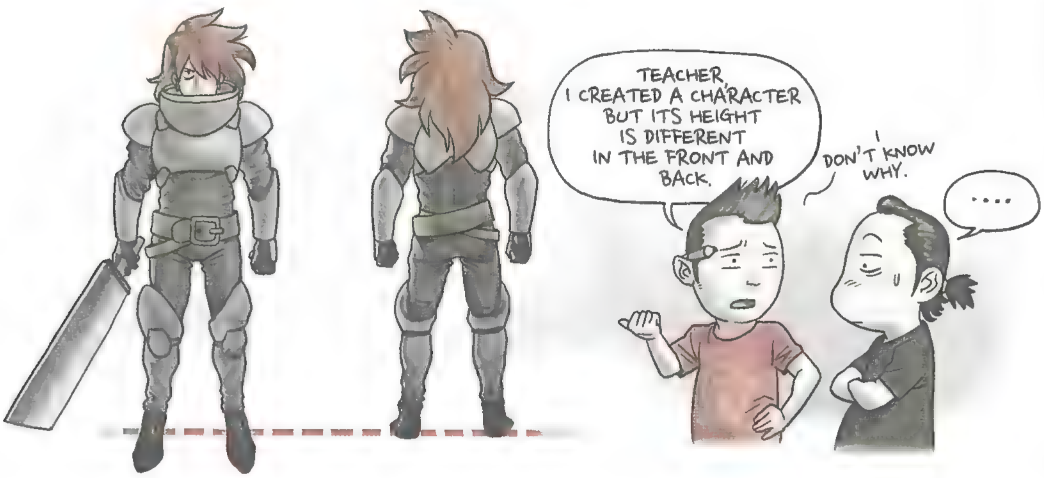
■Various Shapes of the Foot Bones

Below are various shapes of the foot bones observed from different angles. Note the flexing at the metatarsophalangeal joints.

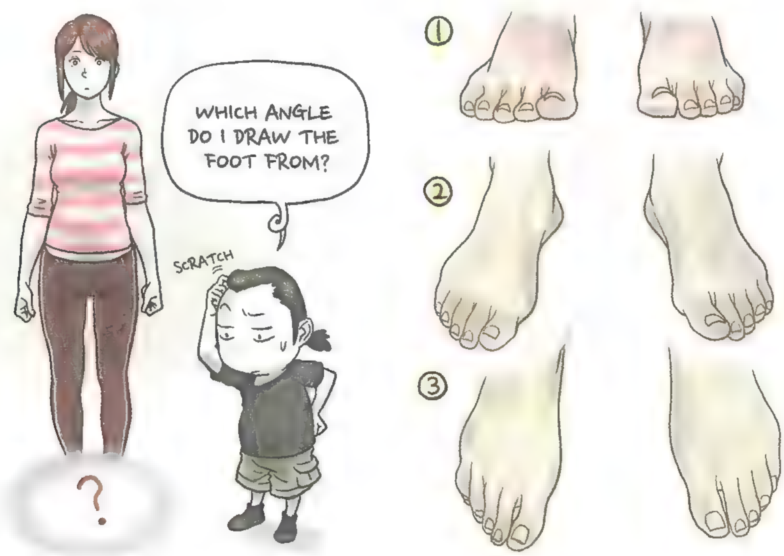


■Let's Draw the Foot

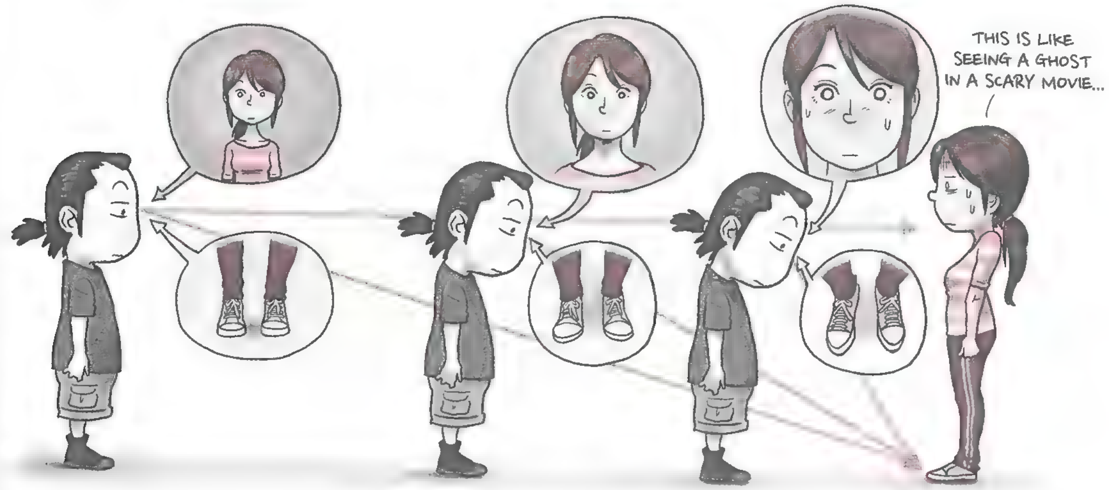
As I mentioned in the opening about the foot, it is easy to find well-drawn hands even though they are complex because the hands play many roles and it is easier to observe them, but it is difficult to find a well-drawn foot. One of the obvious reasons is that the foot is always out of sight. We also have this one wrong perception about the foot.
I remember one incident from when I used to teach at college.



Obviously, this is the same character, but she somehow looks taller from the front and shorter in the back. This is an unexpected challenge for students that are learning illustration. So, let's think about why this is the case. Which feet do you think are the most suitable for the character below?

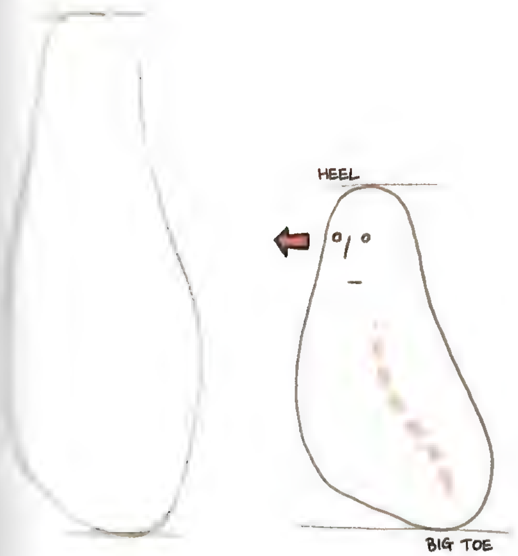


I will start off by giving you the answer. The answer is that, all three can be the answer. It depends on how far away you are standing when looking at the person's feet. Usually, when the observer is at a similar eye level as the observed person, the observer does not feel much difference in depth perception. Conversely, when looking up at a tall building he would see the difference in the depth. But the perception of feet changes depending on where the observer is standing because the feet are flat on the ground.



Nevertheless, we tend to think that feet always look like the third option. That's because this is the view we are used to seeing of our own feet when standing. We can look at our hands by turning the hands around but typically, we only see the top of our feet. This is the reason that we end up drawing our feet as being long and pointing downward even though the feet face the front.'

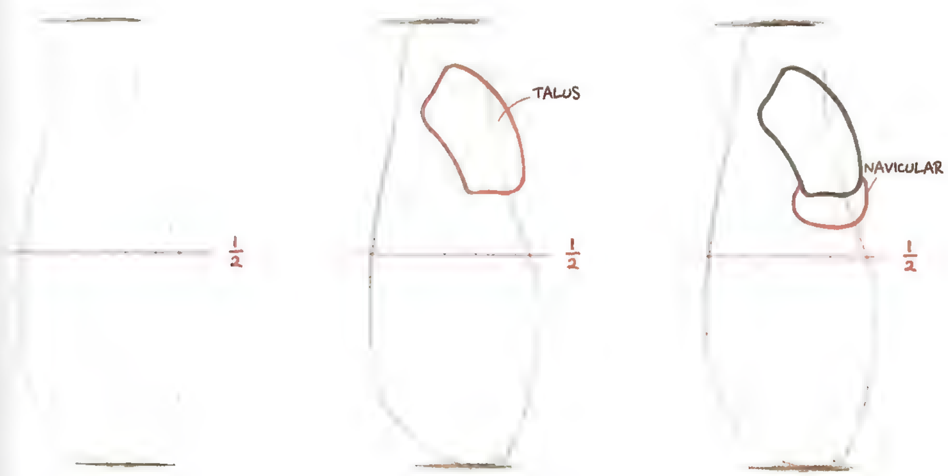
ing the Dorsal View of the Foot Skeleton



01. First, mark the line at the tip of the toe and at the tip of the heel. Next, draw the entire footprint frame as if you're drawing the sole of a shoe.

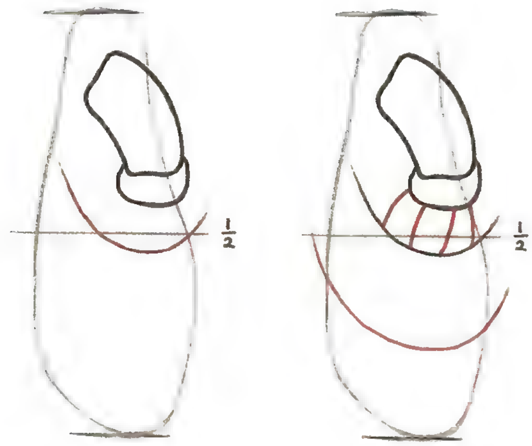
We are going to draw the skeleton inside this frame. To exaggerate a little bit, you must draw it like a roly-poly doll that is slanted on one side, like the drawing on the right.

To sum up, the key is to draw the heel facing the lateral side and the big toe should be drawn towards the medial side.



a horizontal line at the midpoint of the frame, and then draw a wide square frame slanted toward the around where the calcaneus lies, like the picture above. That part is the 'talus' and because this in the air not touching the ground where it is supported by the calcaneus, you don't have to fit within the footprint frame you drew in step one.

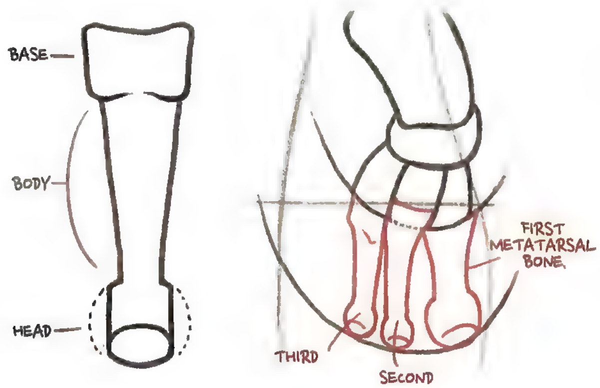
ve drawn the talus, draw a navicular bone right below the talus (towards the front of the foot).



03. As shown on the left, draw a curved line around the mid-length of the entire foot. This curved line will become the tarsometatarsal joint which is the border between the tarsal bones and metatarsal bones.

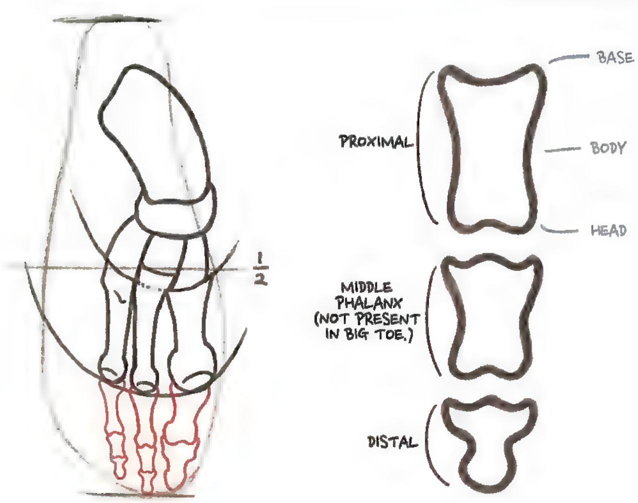
Draw four lines in between the tarsometatarsal joint and navicular bone to express lateral-intermediate-medial cuneiform bones.

Bisect the bottom (front side) of the foot and draw another curved line with a slope following the curve of the tarsometatarsal joint. This will form the border between the metatarsal bone and the phalanges in other words, the metatarsophalangeal joint.



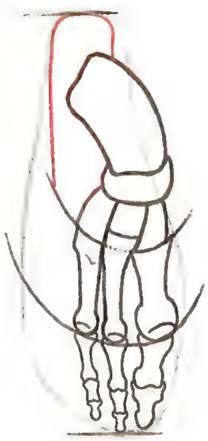
04. Use the left picture as a reference then draw the metatarsal bones in between the two borders. Draw the metatarsal bones as if they are coming out of the cuneiform bones one by one. As you're drawing, to be sure to draw the first metatarsal bone thicker and bigger than the rest of the metatarsal bones.

One more thing, make sure to draw the base of the second metatarsal bone as if it's stuck in between the first and third metatarsal bones.

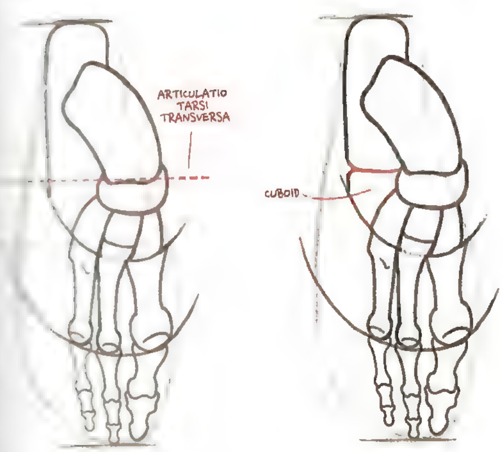


05. It's time to draw the phalanges. Just like the picture on the left, draw the phalanges in order, connected to the metatarsal bones you've already drawn. Please make sure to draw the first phalanx (big toe) without the middle phalanx and draw the rest of the toes with proximal, middle and distal phalanges.

The figure of the foot so far is of the medial half of the foot.

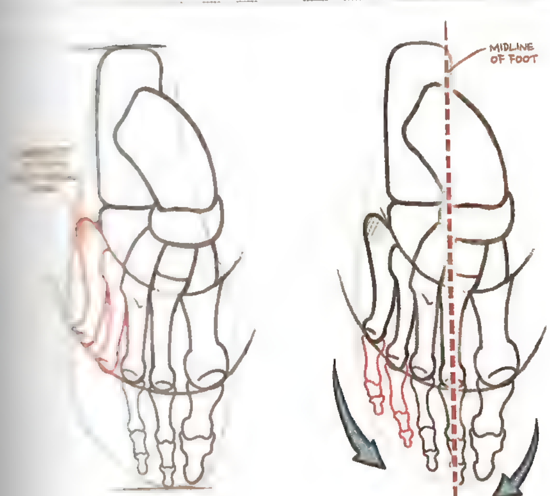


06. From now on, let's draw the lateral half of the foot.
Draw the calcaneus following the pre-drawn heel line.



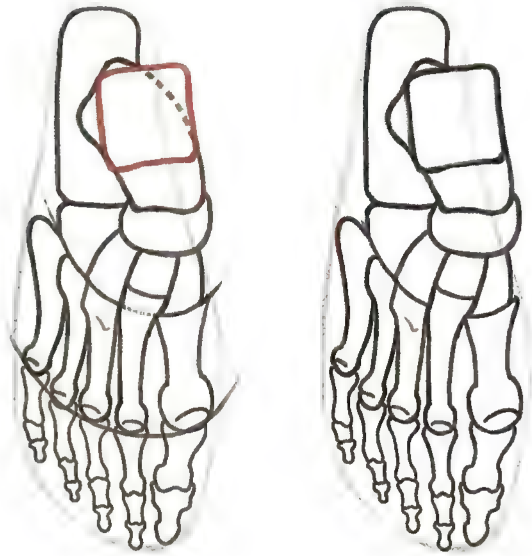
07. Draw a straight line that overlaps with the talus and articular surface of the navicular bone.

This line will become the border between the calcaneus and cuboid bone. If you look at the entire foot, it's the borderline of the articulation tarsi transversa.

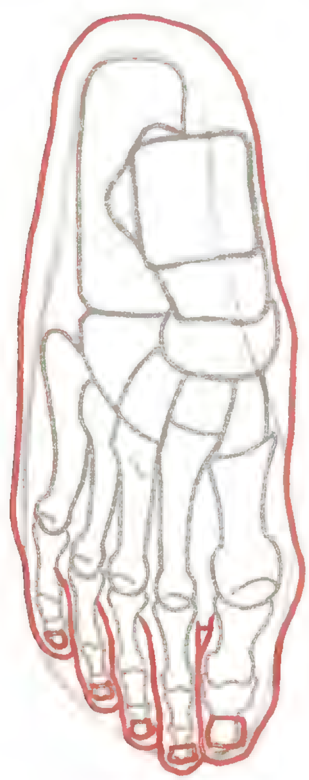


08. Just like how you drew step 4 and 5, draw the fourth and fifth metatarsal bones and phalanges in order. It will look more natural if you draw the toes as if it gathers to the second toe which is the midline of the foot.

The fourth and fifth metatarsal bones start from the cuboid bone. Note that the base of fifth metatarsal bone slightly protrudes towards the side (tuberosity of fifth metatarsal bone).



09. Lastly, the drawing will be [illegible] you draw a slightly [illegible] (trochlea of talus) that [illegible] talus you first drew



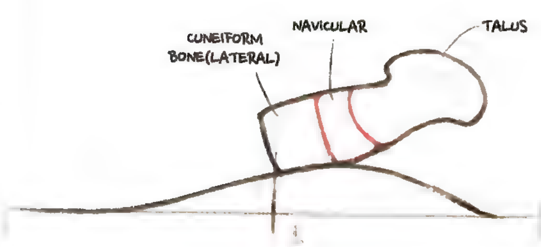
10. Let's draw the outline of the actual [illegible] based on the completed [illegible] and see how it differs from the [illegible] of foot. It is epsecially [illegible] the difference between the [illegible] actual toes split and the shape of the skeleton.

Drawing the Medial View of the Foot Skeleton

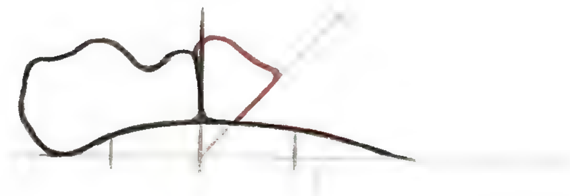
01. As above, set the boundary of the front tip and rear of end the foot (toes and heel), then mark a reference point in the middle.

02. Draw a curved line so that the height is slightly higher towards the back than the front.
This curved line shows the medial longitudinal arch.

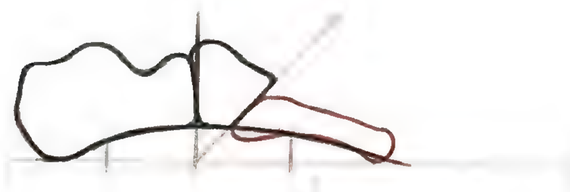
03. Draw a tarsal bone shaped like a pine mushroom, facing backwards (towards the right) starting from the middle of the reference line.



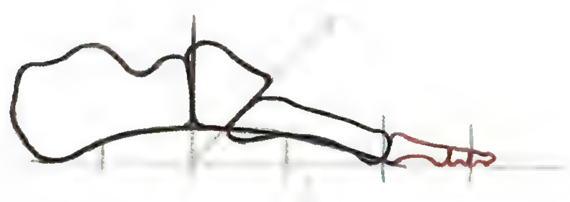
04. Divide the tarsal bone into three parts. Each part becomes the medial cuneiform bone, navicular bone and talus.



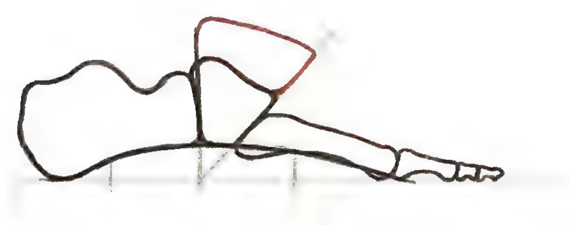
05. Draw the cuboid bone inside the previously drawn cuboid's base line. Please do not erase this line for the time being.



06. Next, draw *the fifth metatarsal bone* in front of the cuboid bone. Here, don't forget to draw a protrusion to show the *tuberosity of the fifth metatarsal bone.*

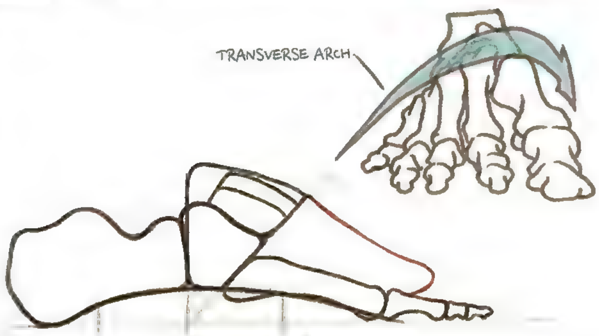


07. Draw the fifth metatarsal bone. The *fifth metatarsal bone* is the shortest, therefore, it ends approximately at the 5/6 point in relation to the total foot size.



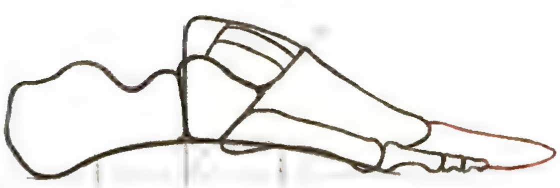
08. Coming back to the cuboid bone, this time let's draw the expanded area above the cuboid bone as shown in the picture.

09. This part is the navicular bone, medial, intermediate, lateral cuneiform bones seen from the side.

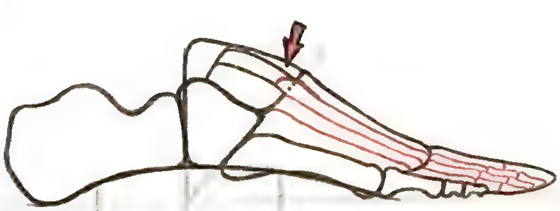


10. Mark an expanded area that is slightly slanted in front of the cuneiform bone. This area is for the remaining metatarsal bones.

The transverse arch of the foot increases the slope towards the big toe, so if you look from the side, the metatarsal bones look like stairs.

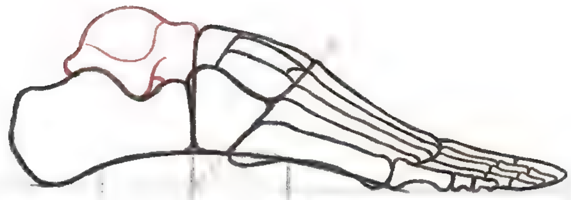


11. Mark the area of the phalanges. Ensure that they reach the tip of the entire foot.

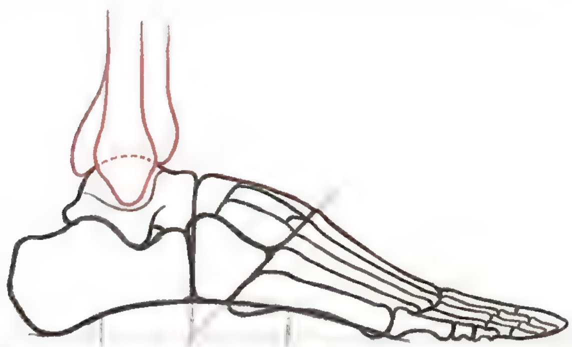


12. Draw lines inside the expanded area to show the metatarsal bones and phalanges as shown in the picture.

Please pay attention to the base of the second metatarsal bone. It pushes and inserts itself into the cuneiform bone.

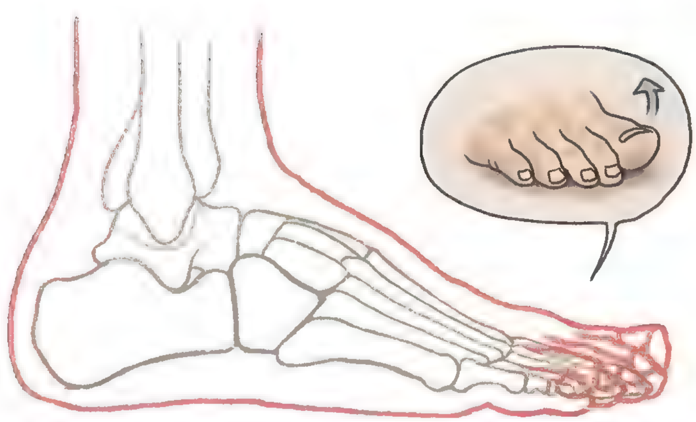


13. Let's draw the shape of the talus sitting on the calcaneus in a circle shape as if we're putting the puzzle pieces together

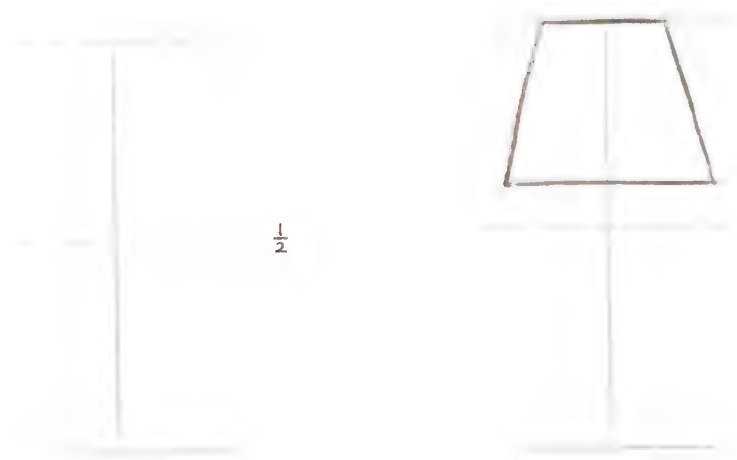


14. Once you draw the lateral malleolus above the talus and below the fibula, as well as the tibia visible at the back, you will be finished.

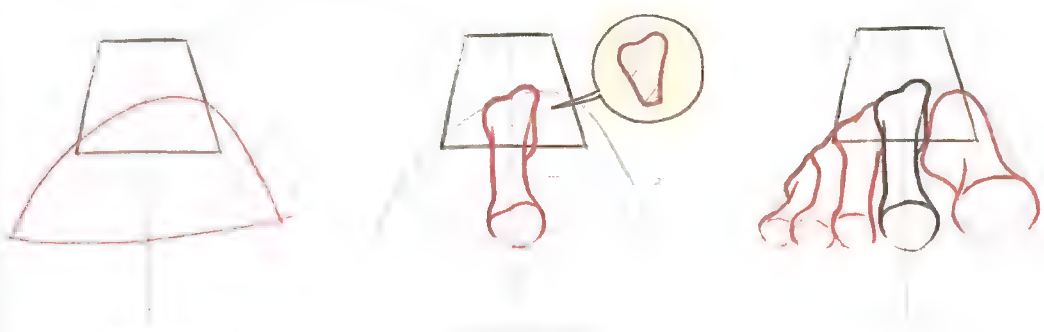
15. This is the outer appearance of the foot. Make sure to draw the first toe slightly facing up while the remaining toes point down towards the ground.



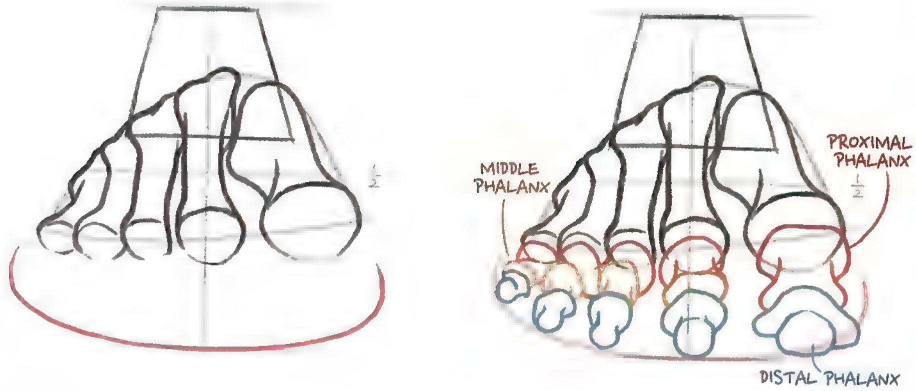
❹ Drawing the Front View of the Foot Skeleton



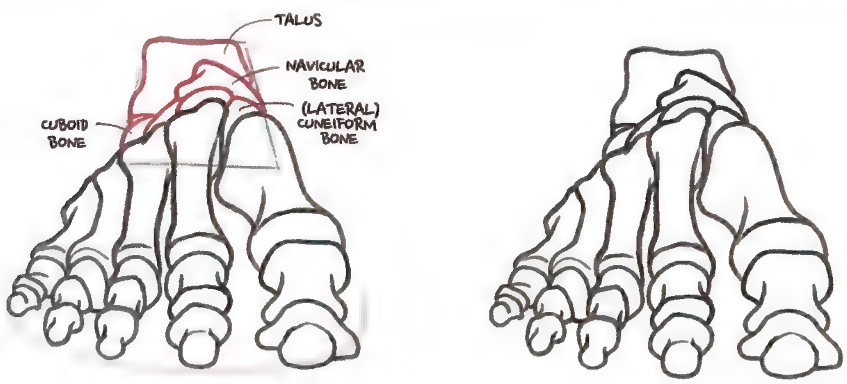
1. To draw the foot as seen from the front, let's use a vertical guideline this time. (This guideline serves as the height of the foot.)
2. By drawing a trapezoid in the upper area (as shown in the picture), it becomes the area of the talus including the tarsal bone.



3. It's time to draw the metatarsal bones. As shown in the picture above, draw a smooth and medially slanted semicircle shaped frame that extends about half the entire area of the foot. This area falls under the transverse arch of the foot.
4. If you are done drawing the frame, draw the second metatarsal bone at the center of the frame or the center line of the foot just like the example on the right. It will look more realistic if you express what the base of the second metatarsal bone (speech bubble) looks like.
5. Based on the second metatarsal bone, draw the remaining metatarsal bones on the medial and lateral sides. Normally, we would draw the *cuneiform bone* and *cuboid bone* because they are the starting points of the metatarsal bones but because they are hard to see at this angle, it's okay for us to omit them for the time being.



06. Let's draw the toes this time. Based on the guideline below, draw a wide oval-shaped base line, then draw the five digits starting with the first toe.



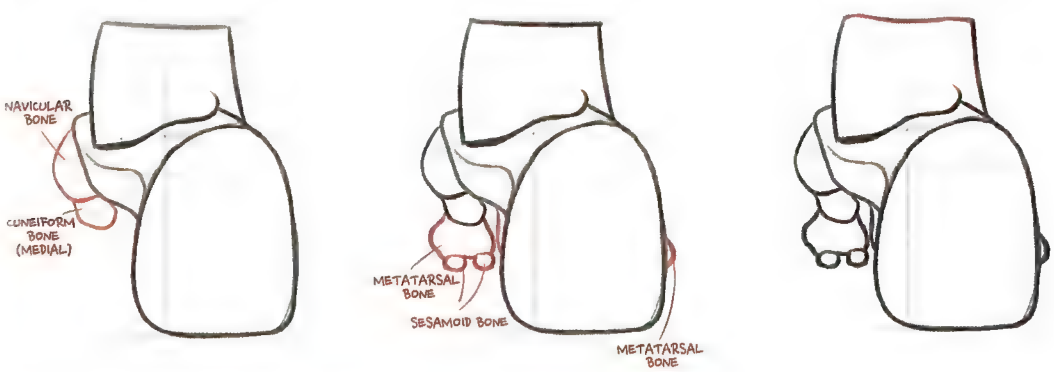
07. Lastly, draw a more concrete line for the tarsal bone that we had drawn roughly before in step one and when you erase the guidelines, it will be done.

08. Let's draw the outer appearance of the foot on top of the skeleton.

❺ Drawing the Back View of the Foot Skeleton

01~02. Based on the cross guideline, draw a slightly slanted trapezoid in the upper area. This is the talus as viewed from the back.

03. Draw the calcaneus slightly flat on the side in a downward direction near the talus' lower side.



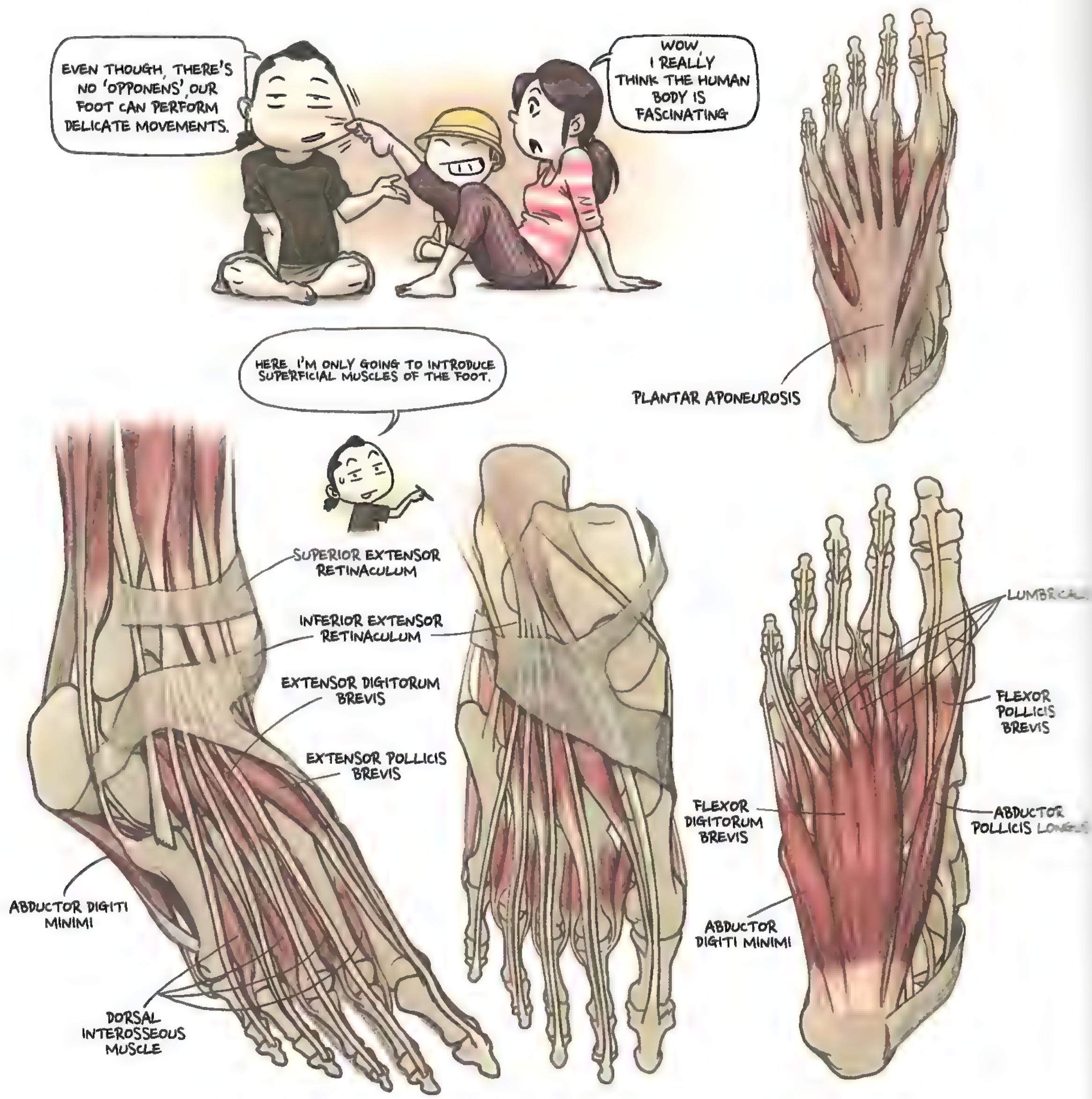
↑ **04~05.** Draw the navicular bone, medial cuneiform bone, metatarsal bone and sesamoid bone which are in front of the talus.

06. Lastly, finish it by refining the trochlea of the talus part at the top of the talus.

← **07.** Based on this skeleton, draw the outer appearance of the foot. It is normal for the heel to face the side slightly.

Distinct Muscles of the Foot

It may sound obvious, but just like the hands, our feet have their own distinct muscles. However because human's feet are somewhat simple compared to the hands, the foot muscles are slightly different from the hands. Compared to the hands, there is no *opposition* found in our foot. Another major feature is that the dorsal muscles of the foot are more developed compared to the back of the hand.



Let's Attach the Foot Muscles

There are few muscles on the dorsum of the foot.
Nevertheless, it feels complicated because the long tendons of the muscles starting at the calf, cover the whole foot.
That is why it is a good idea to review the order of the muscles on the calf and draw them to the foot.
The intrinsic muscles of the foot are marked in red while the tendons of the calf are marked in blue.

❶ Bones of the foot (Dorsal side)

01. Peroneus brevis, peroneus longus (tendon), sole muscles

02. Dorsal interosseous muscle

03. Extensor hallucis brevis

04. Extensor digitorum brevis

05. Peroneus tertius (tendon)

06. Extensor digitorum longus (tendon)

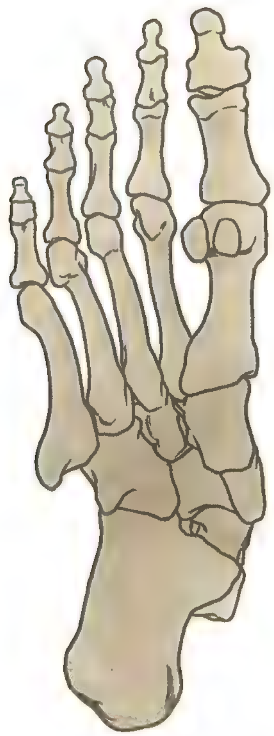
07. Extensor pollicis longus (tendon)

08. Tibialis anterior (tendon)

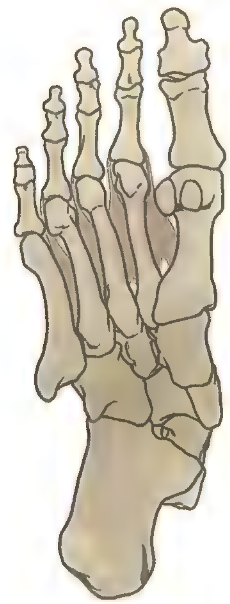
09. Inferior extensor retinaculum

10. The dorsal side of the foot is completed

This time we see the sole of the foot.
Just like the top of the foot, please note and follow along where the muscles are connected, starting from the calf.



❷bones of the foot (sole side)



01. dorsal interosseus muscle

02. palmar interosseus muscle

03. flexor digiti minimi brevis/ adductor hallucis muscle

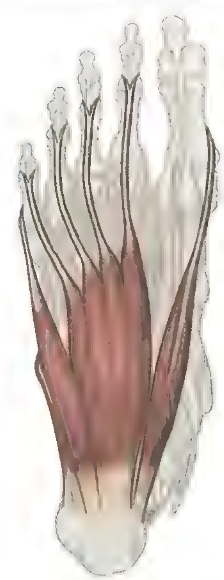
04. peroneus brevis/tibialis posterior muscle

05. peroneus longus muscle

06. flexor digiti minimi brevis / flexor hallucis brevis muscle

07. long plantar ligament / flexor hallucis longus muscle

08. flexor digitorum longus muscle /lumbrical/quadratus plantae muscle

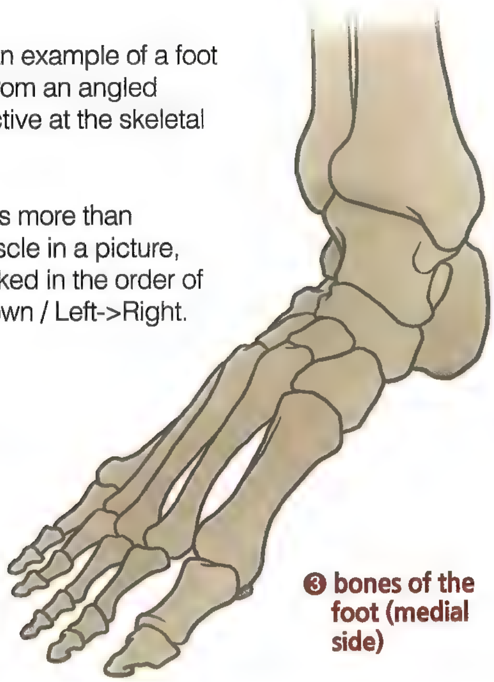


09. abductor digiti minimi/ flexor digitorum brevis/ abductor hallucis muscle

10. aponeurosis plantaris/ flexor retinaculum

This is an example of a foot drawn from an angled perspective at the skeletal level.

If there is more than one muscle in a picture, it is marked in the order of Up->Down / Left->Right.



❸ bones of the foot (medial side)

01. Peroneus brevis, flexor digitorum longus muscle, achilles tendon

02. Flexor pollicis brevis, plantar aponeurosis, abductor pollicis, tibialis posterior (tendon), flexor digitorum longus tendon

03. Peroneus tertius muscle (tendon), abductor hallucis muscle

04. Extensor digitorum brevis, extensor hallucis brevis muscle

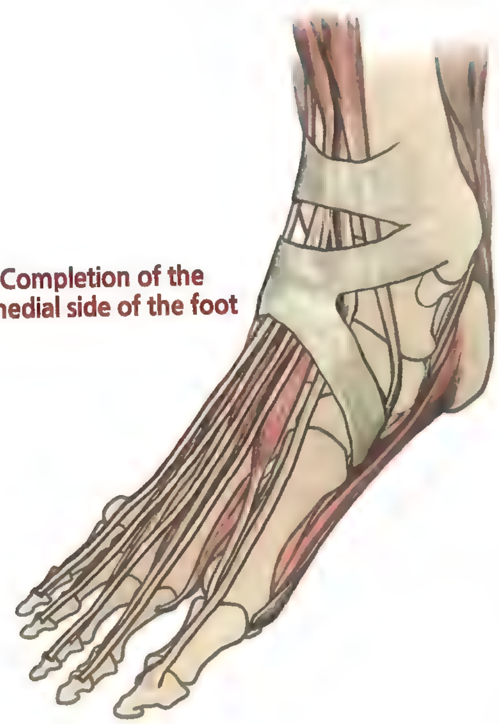
05. Extensor digitorum longus muscle (tendon)

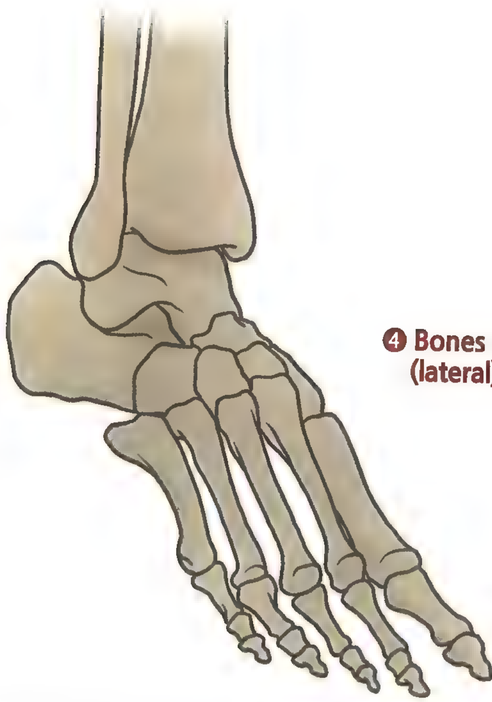
06. Extensor pollicis longus muscle (tendon)

07. Tibialis anterior muscle (tendon)

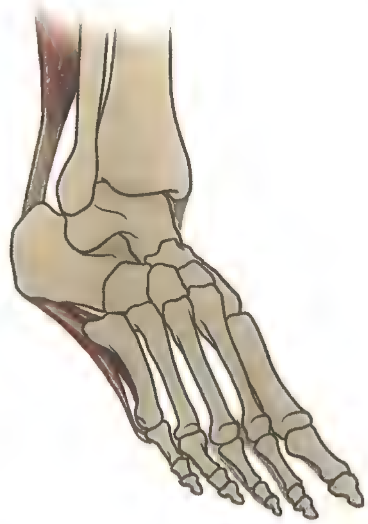
08. Superior/Inferior extensor retinaculum

09. Completion of the medial side of the foot





❹ Bones of the foot (lateral)



01. Abductor digiti minimi muscle, achilles tendon

02. Dorsal interosseous muscle

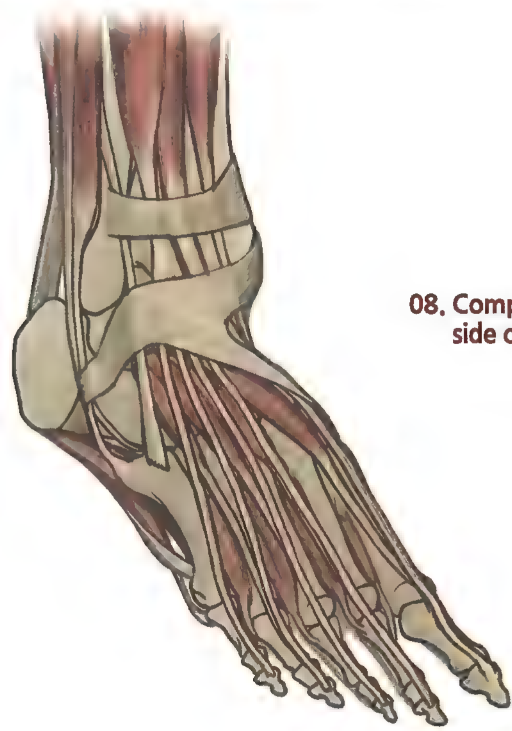
03. Peroneus longus muscle, aponeurosis plantaris

04. Peroneus brevis muscle (tendon),
extensor pollicis brevis,
extensor digitorum brevis,
tibialis anterior (tendon)

05. Extensor pollicis longus muscle
(tendon)

06. Extensor pollicis longus muscle
(tendon)

07. Superior / Inferior extensor retinaculum



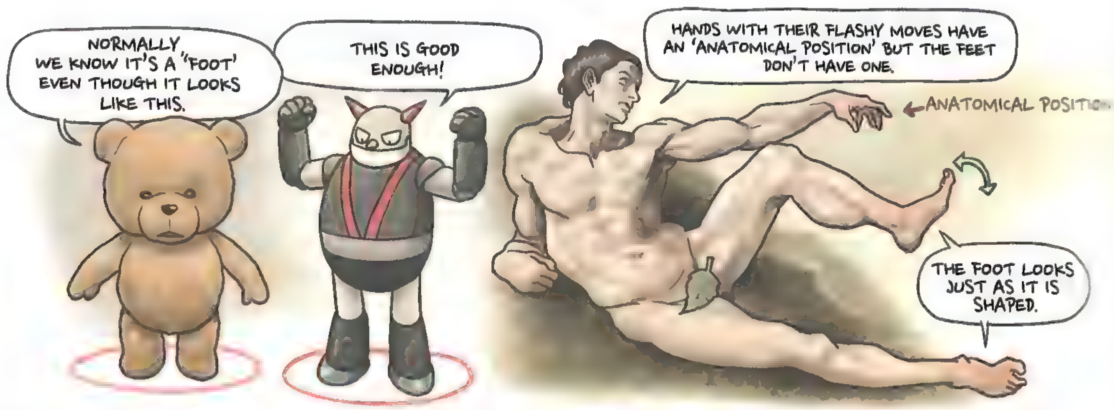
08. Completion of the lateral side of the foot

The 'plantar flexion' posture, which lifts the heel by contracting the soleus and gastrocnemius of the calf, not on makes the calf appear visually more supple and slim, but also blurs the distinction between thedorsum of the foot and the shin, making the legs look longer overall. High heels are effective in maintaining this posture.

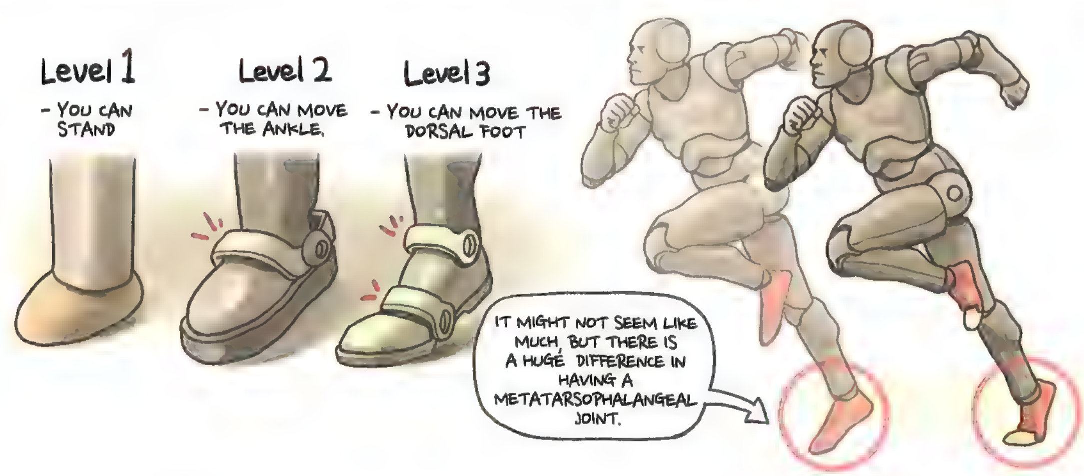
Let's Draw Shoes

■Why Shoes?

So far we have drawn the shape of the foot skeleton from many different angles. What did you think about it?
The drawings might have been a little complicated, but I'm sure these exercises have changed the way you look at feet.
If you are able to draw the feet like the exercises, then you have pretty much mastered the art of drawing feet. Because, as I already mentioned, feet don't have obvious movements like hands and just being able to draw the three-dimensional foot is a feat in itself.



Nonetheless, there must be some keys to making the feet look more 'like feet.' We all know that our feet only have simple movements, but the ripple effect of those simple movements on the overall balance of the entire body is really powerful. A major example of this is the movement of the metatarsophalangeal joint, or the dorsiflexion (extension) and plantarflexion.



As mentioned, the movement of the metatarsophalangeal joint is the biggest and most basic motion of the feet. That is why this movement is the biggest point to consider when making shoes. Also, because we are more used to seeing shoes than bare feet, it is important to take a close look at shoes.

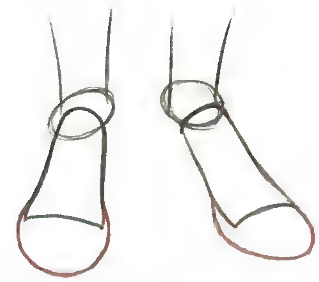
Not just shoes, but all human clothing is intended to protect the body from external physical stimuli, but also to cover the body's weak points and to maximize its functionality. So, the structure of shoes can provide a clue for us to better understand the shape of our feet. Since you have studied the foot skeleton already, learning about shoes as well will maximize your understanding of the foot. Now, are you ready to draw shoes?

It is said that Michelangelo, who was painting the ceiling of the Sistine Chapel, corrected a part that was not even visible from the floor. When his assistant complained Michelangelo replied that "God knows and I know." I don't know about God's existence, but I know one thing for certain: shoemakers will definitely look closely at shoes.

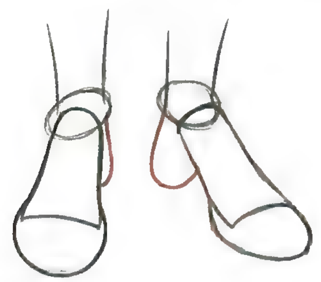
❶ Drawing Sneakers

01. Mark the oval-shaped malleolus below the shin. The oval-shape should be slightly higher on the inner side. Roughly outline the size of the entire feet.

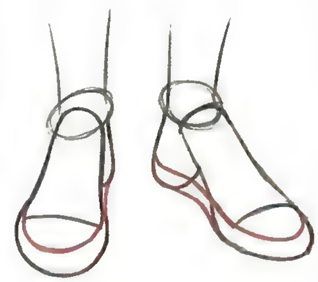
02. Draw the dorsal side of the foot consisting of tarsal and metatarsal bones. The key here is to draw the feet wider towards the bottom.



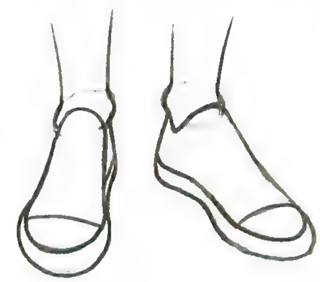
03. Draw the toes like they are slightly covering the dorsal side of the foot. The medial side is the shape of a sharp circle.



04. Now, let's draw the heel part. It's better to draw it as if it is more erect than the actual bone.



05. Draw a concave line connecting the heel and toes (front of feet). This is the medial longitudinal arch.



06. Carefully erase overlapping sketch lines with an eraser. The drawing will already roughly start to look like shoes.

07. Draw the 'shoe tongue' and both sides of the shoes where shoelaces connect.

08. Draw holes for the shoelaces. Usually, there's 5~7 holes on each side.

09. Draw the shoelaces crossing in an X-shape. Please pay attention that the shoelace is a straight line '-' at the very bottom.

10. Draw the top knot of the shoelaces in a ribbon.

11. Carefully erase any overlapping lines with an eraser. Add details by drawing lines on the sole and tongue of the sneakers.

12. Once you decorate the shoes with sewing lines and logos, they will look even more real. This completes the shoes!

❷ Drawing Leather Shoes

01. The process of drawing leather shoes is identical to drawing sneakers until step 3. But the toe-caps should be sharper for leather shoes.

02. Draw round heels. The heels can be slightly small because they will be supported by the 'heel of the shoes' from below.

03. Draw lines that connect the heels and the front of the feet

04. Erase all overlapping lines with the ankle. Mark the shoe vamp boundary lines on the top and bottom like the picture.

05. Draw trouser cuffs covering the shin and draw 'vamps' that gather forward from the side of shoes.

06. Draw shoelaces, knot, and couple of folds near the center of the vamps.

07. Lastly, once you draw the 'tongue' slightly visible at the ankle, the basic structure of the leather shoes is completed.

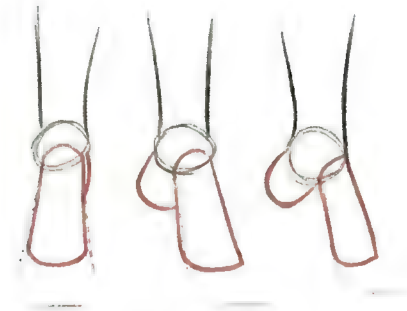
08. Leather shoes are normally made up of shiny leather materials, so it is crucial to depict the gloss.

09. Paint the entire shoes using darker color then highlight parts by carefully erasing them

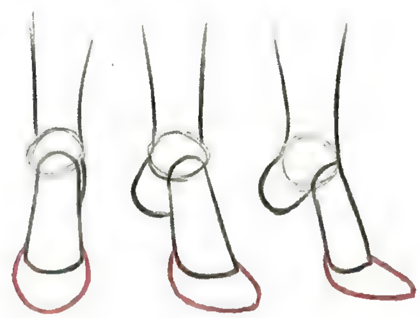

COMPARED TO SNEAKERS, THE FRONT IS RELATIVELY LOW AND THE HEEL IS TALL.
THE KEY IS TO DRAW A SLIGHTLY SHARP FRONT.
METATARSOPHALANGEAL JOINT.
ACTUAL LENGTH OF FOOT.
COMBAT BOOTS ARE VERY SIMILAR TO LEATHER SHOES, BUT THE TOE CAP IS A LITTLE BIT MORE BULGED.
COMBAT BOOTS.
LEATHER SHOES.

❸ Drawing High Heels

01. In the same manner that we drew sneakers earlier, roughly mark the shin and malleolus and outline the entire size of the feet.



02. Draw guidelines for the dorsal side and heels.



03. Mark the toe area as it wraps around the tip of foot. The heel is lifted so the entire foot will bend at the metatarsophalangeal joint.

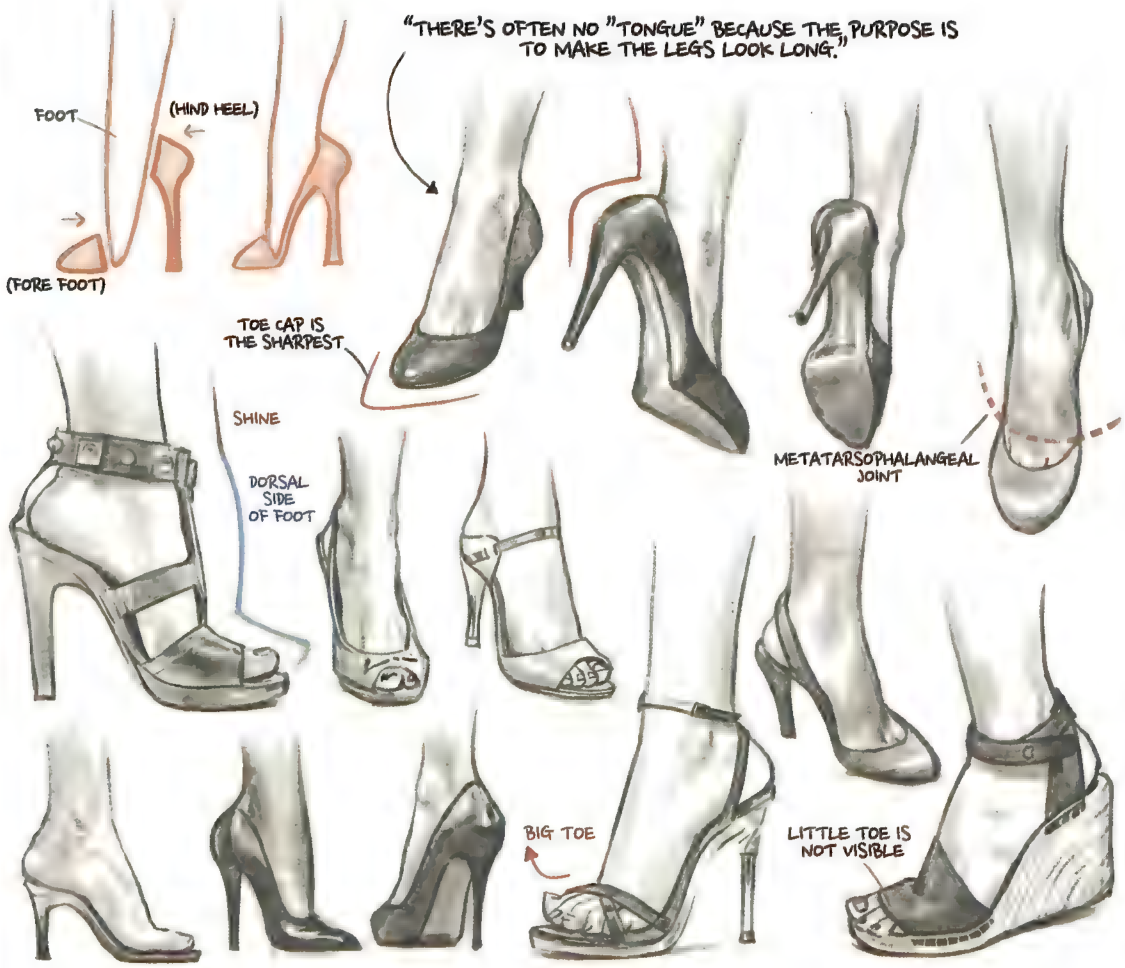
04. Connect a line from the end of heel to the toe area then draw high heels at the heel of the foot.

05. Carefully erase all overlapping or messy lines and parts.

06. Draw a boundary line that distinguishes high heels and feet.

07. Roughly sketch the malleolus of the ankle. This is the basic figure of a typical high heel

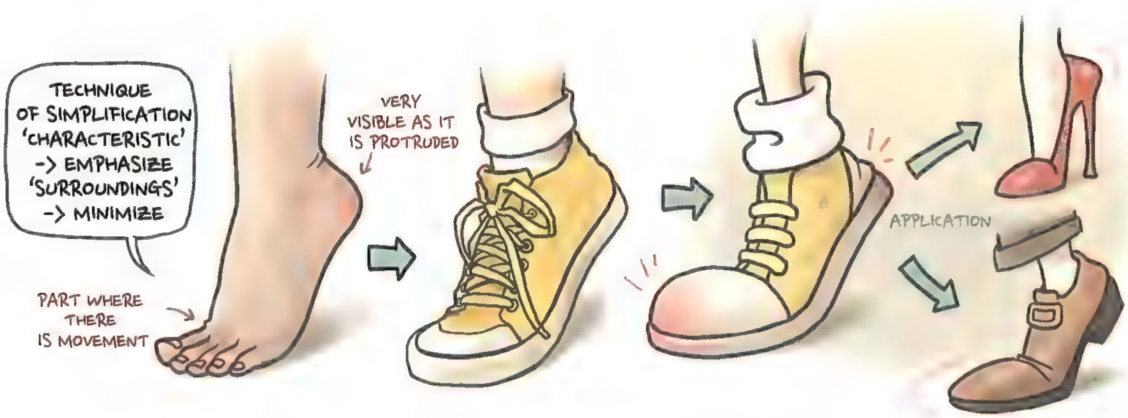
08. Based on the basic figure, you can draw various designs by adding or removing accessories.



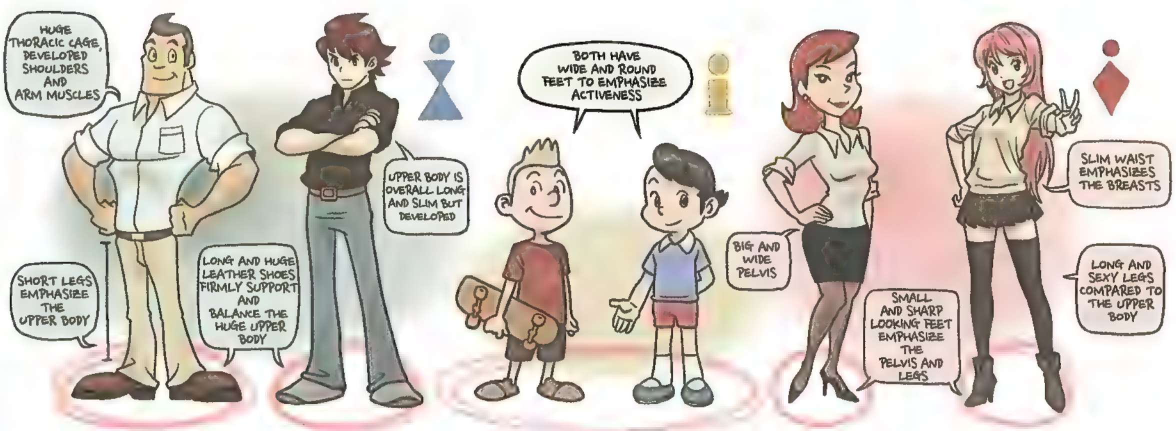
■Simplification of the Feet and Shoes

You deserve a round of applause for all of your hard work. The feet are usually farthest from our thoughts, so I wanted you to take a closer look and do some more practice exercises. Whichever field you study, it is necessary to take time to "digest" the content. So, don't feel disappointed if you can't memorize everything. Enjoy the rest of the lesson like you are having dessert after a meal.

Simplified drawings tend to be thought of as being less important than other realistic and detailed illustrations. However, it is not possible to simplify an object without first understanding the real object. That is why it is important to look at how 'feet' are drawn in cartoons or illustrations. They are examples that maximize certain external appearances of the foot's structure.



As I mentioned earlier, because the *foot* is a limb that is supposed to safely and efficiently support the body, the foot is affected by the overall shape and functionality of the body. This becomes more pronounced when you draw the entire body of a character.

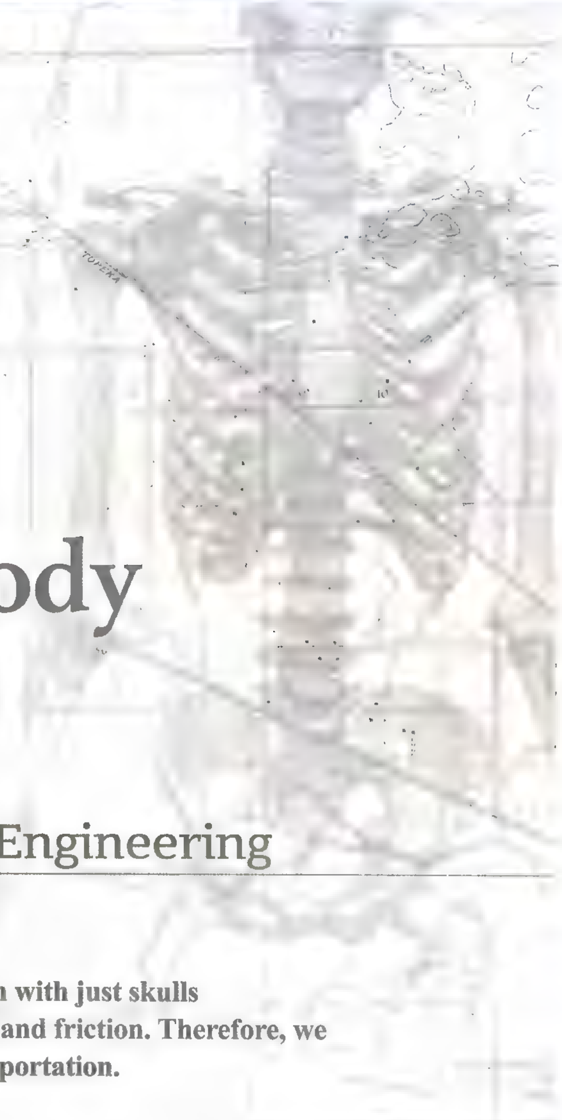


These are examples that I came up with. On the left are American style cartoons and on the right are typical Japanese characters. We can see that the expression of feet and the points for simplifying the human body are not much different between the East and West.

Well, this is the end of the story about feet. Despite its important role, we are unfamiliar with our feet. But our feet are complex anatomically, physiologically and artistically. I hope this opportunity to think about and to observe the mysterious structure will serve as a way for us to show appreciation to our feet.

Why don't we give our feet a good rest by giving them a massage tonight?

MUSE / painter12 / 20



VII
Entire Body

The Pinnacle of Engineering

It is not easy to move freely on earth with just skulls and spines when there is gravity, air pressure and friction. Therefore, we need a special means of transportation.

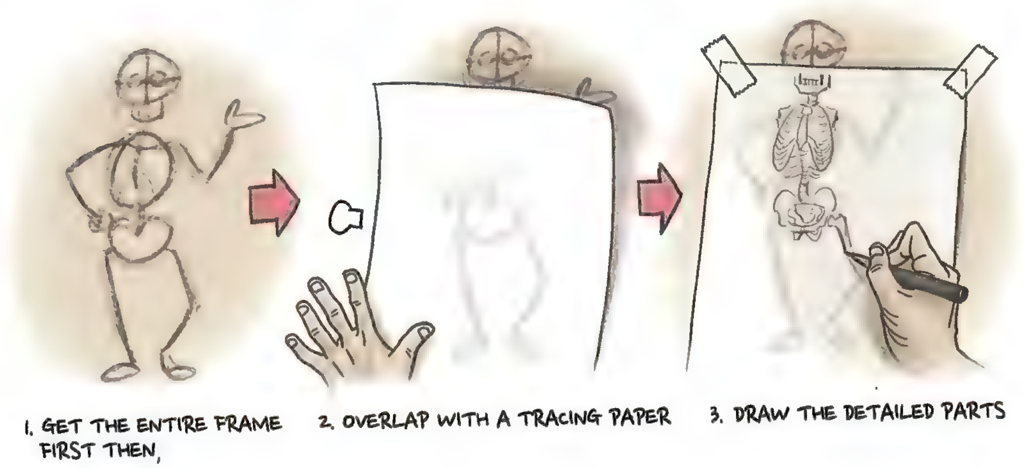
Let's take a closer look at how a human's arms and legs function to help our survival, how are they designed to perform their roles, and how they differ from other vertebrates.

Skeleton of the Entire Body

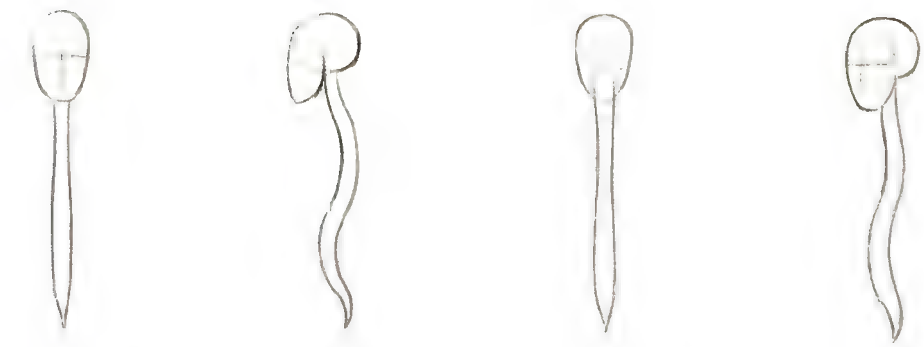
■Drawing the Skeleton of the Entire Body

Finally, the time has come to draw the skeleton of the entire body. Don't be intimidated because it is just going to be the sum of the parts you've already drawn previously.

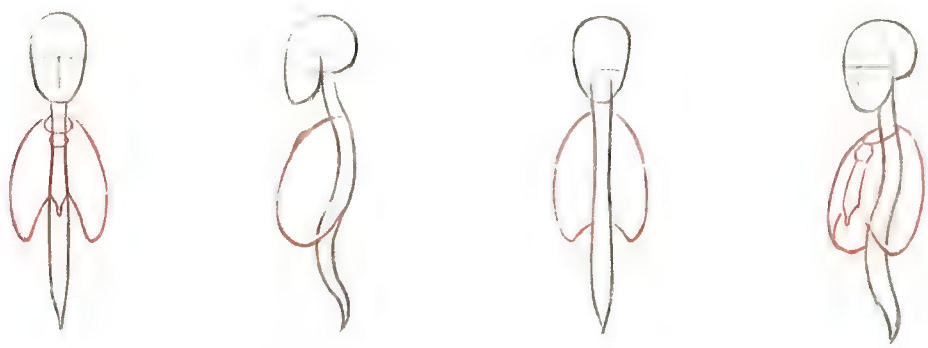
As this is the final review for drawing skeletons, prepare a 'light box' or tracing paper along with pencil and paper, just like when you drew muscles. As you know, we need to first get the outline of the entire frame then start adding the details.



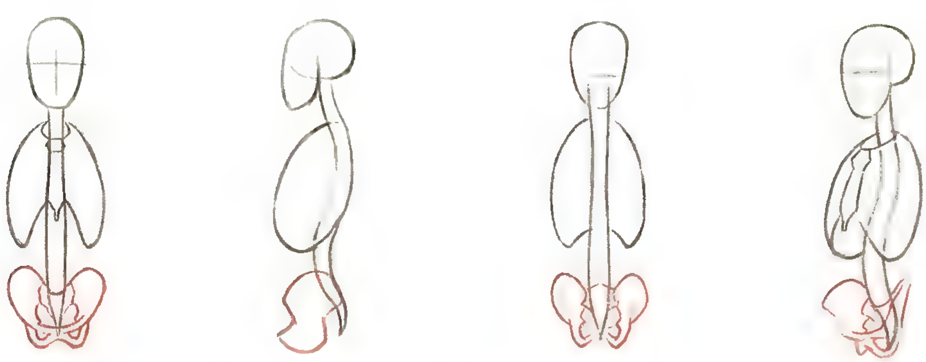
Drawing the entire skeleton is a step you must take if you are studying 'human anatomy.' This is an important exercise because it helps with learning how muscles interact with the body. I recommend you draw as if you're doing a final review of what you've done so far.



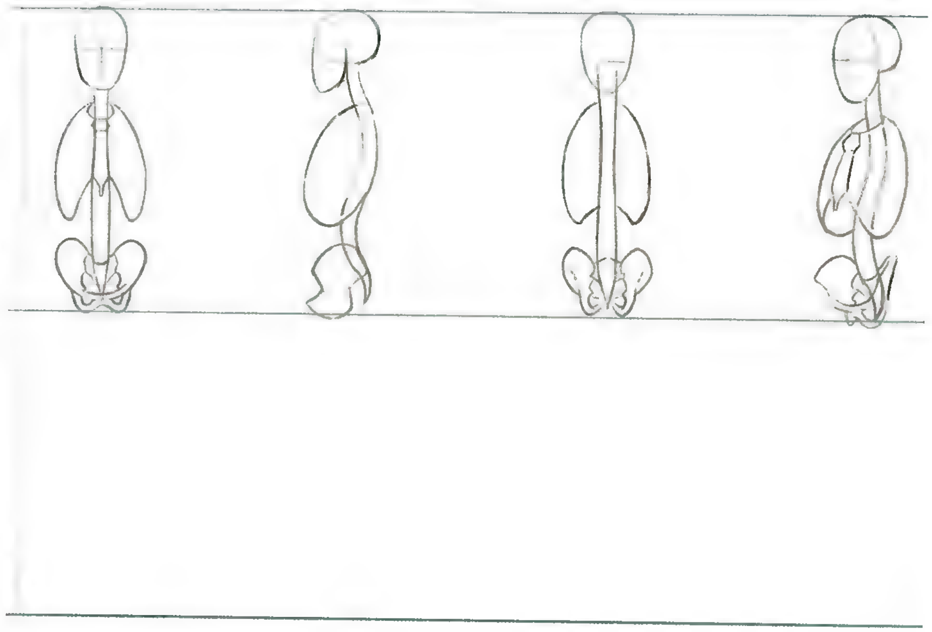
01. This is the head and spinal column. Think of a tadpole and pay special attention to the first and second curves that are clearly visible from the side.



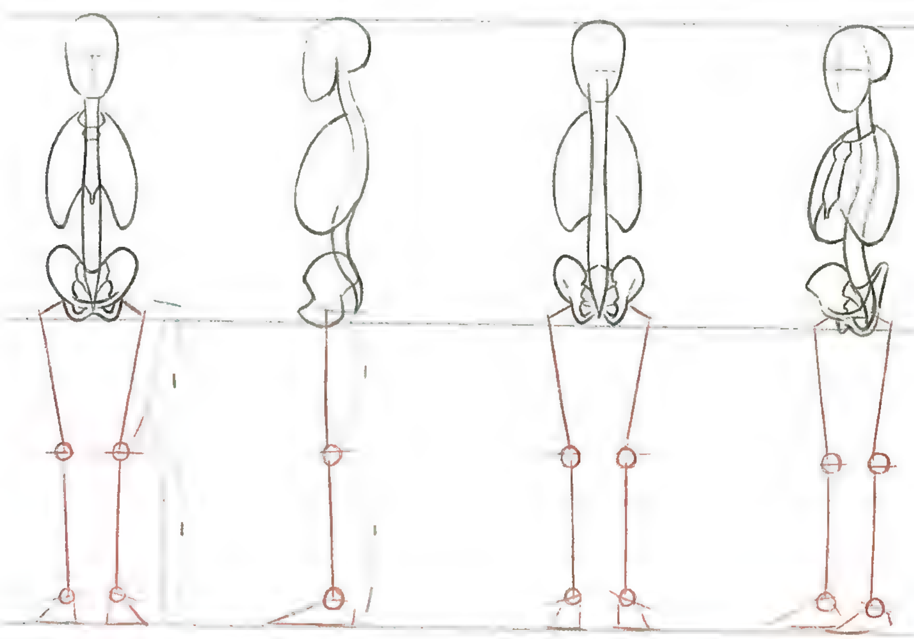
02. The thoracic cage situated at the center of the spinal column looks from the side as if the distal part is slightly lifted. In this area there are also axial bones.



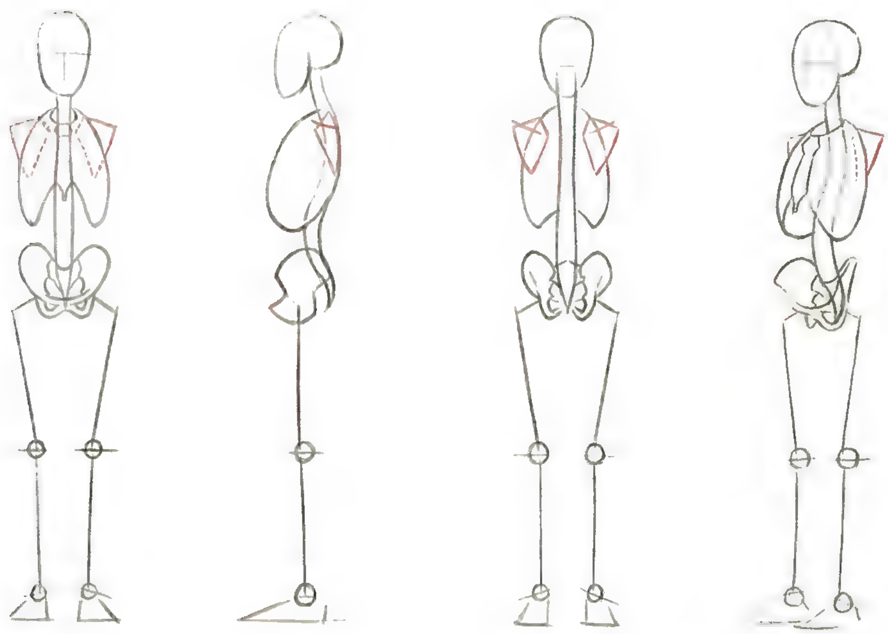
03. Draw the sacrum and pelvic bone below the spinal column. It is necessary to draw it in more detail compared to the head or the thoracic cage.



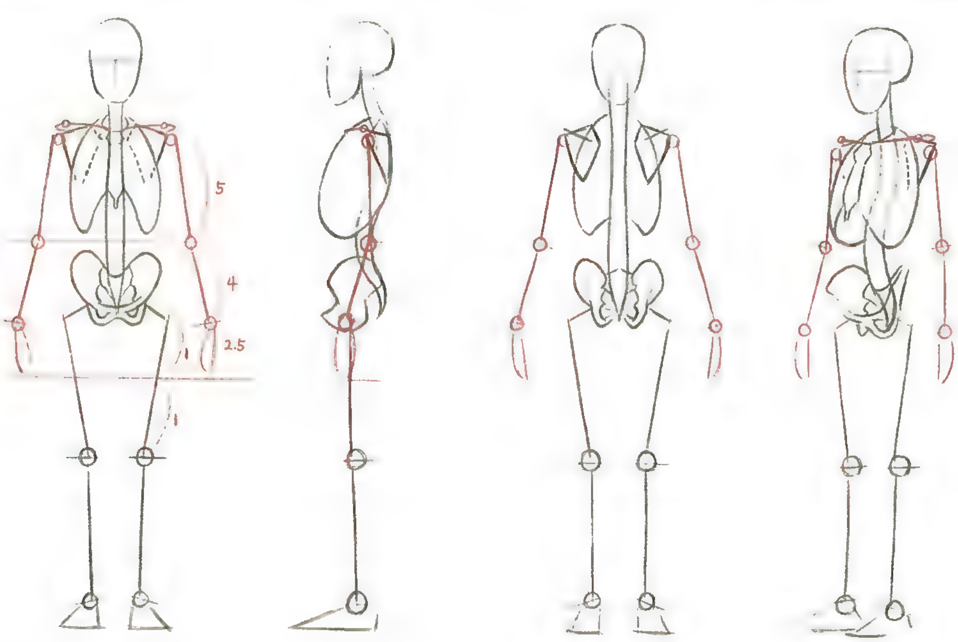
04. Once you're done with the pelvis, this becomes the so-called 'upper half of the body.' Mark a reference line below, equal in length to the upper half. This will become the area for the lower half or the area of the legs.



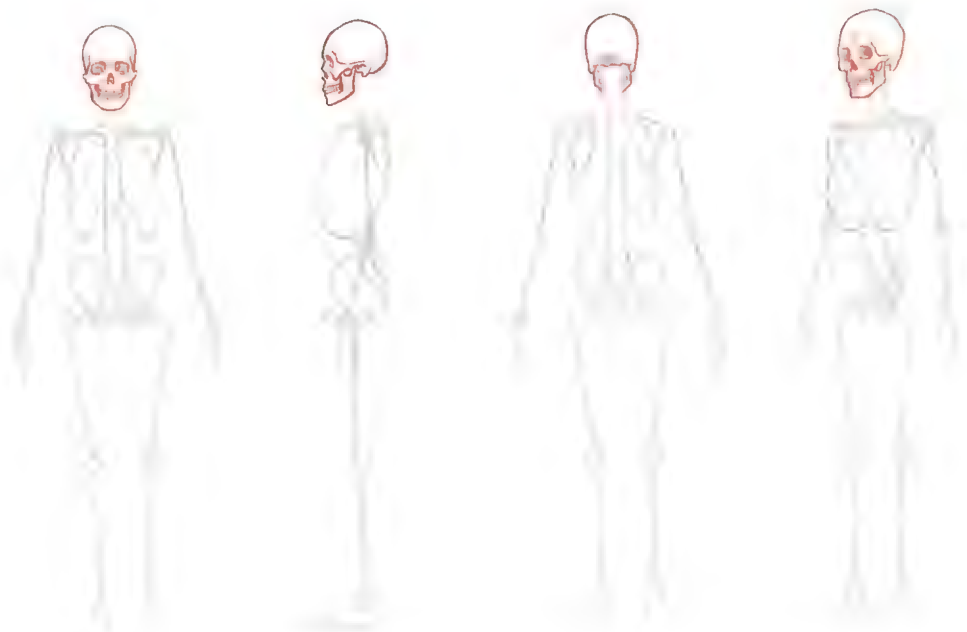
05. Divide the lower area into two even parts and mark the top half as the thigh and lower half as the shin and feet. Usually, the femur is longer than the shin but if you add the height of the shin and foot, the two become the same height. The entire leg is closer to a Y-shape than an I-shape.



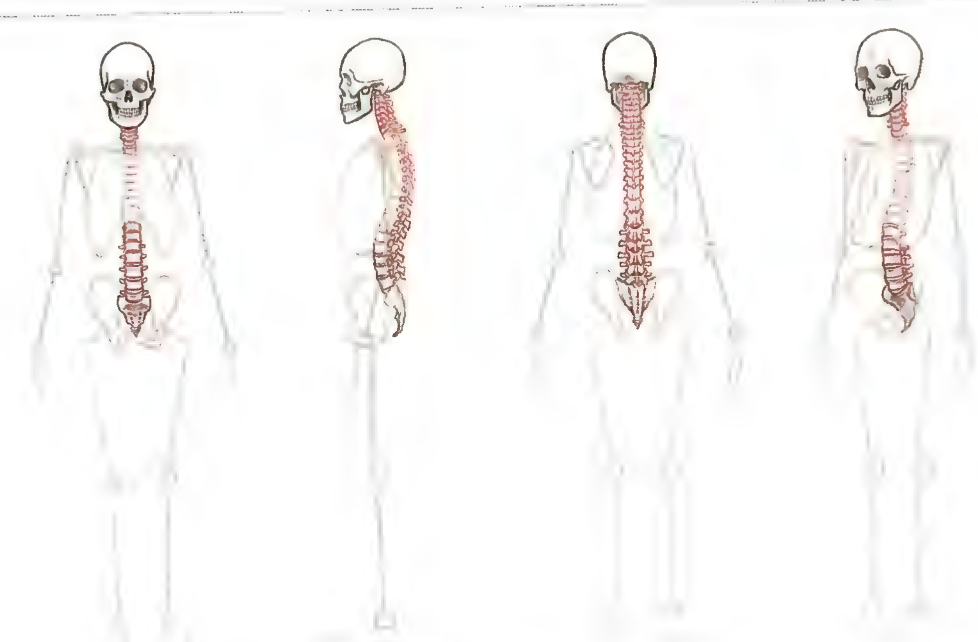
06. Draw the scapula at about the half-way point above the posterior side of the thoracic cage. Also illustrate the spine of scapula by drawing a diagonal line from the top of the shoulder.



07. Once you draw the clavicle, which is connected from the head of sternum and acromion, this becomes the shoulder girdle. Based on the placement of the shoulder girdle, draw the humerus -> forearm bones (radius and ulna) -> hands, in this order. Make sure to pay attention to the ratio of each part. If the ratio is right, the tip of the hands should be at about half-way down the femur.

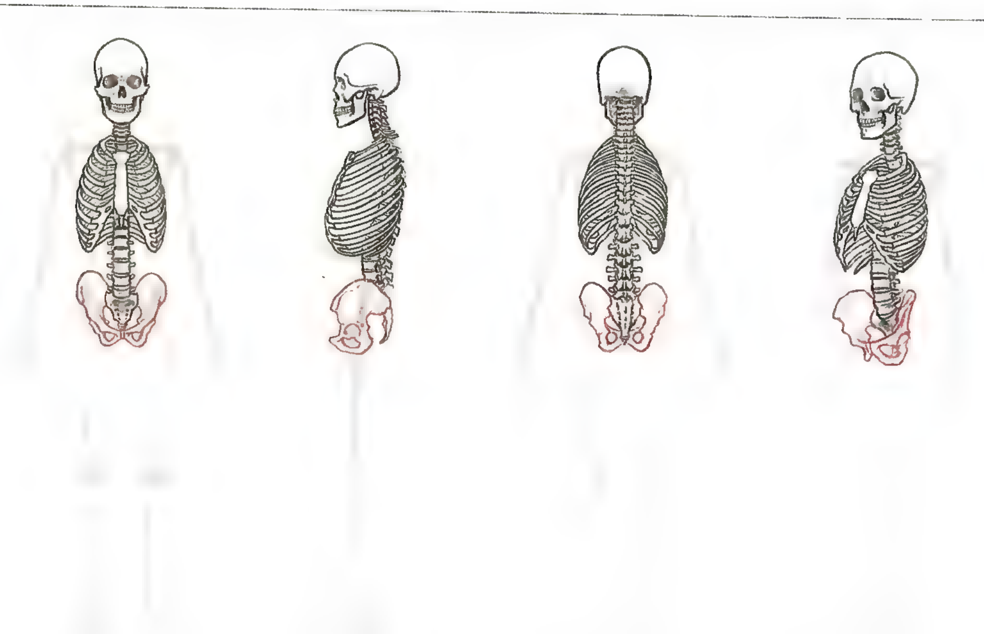


08. Fix a tracing paper on top of the pre-completed guide sketch, then mark the details starting from the skull. For information on how to draw each part, including the skull, please refer to the previous chapters.

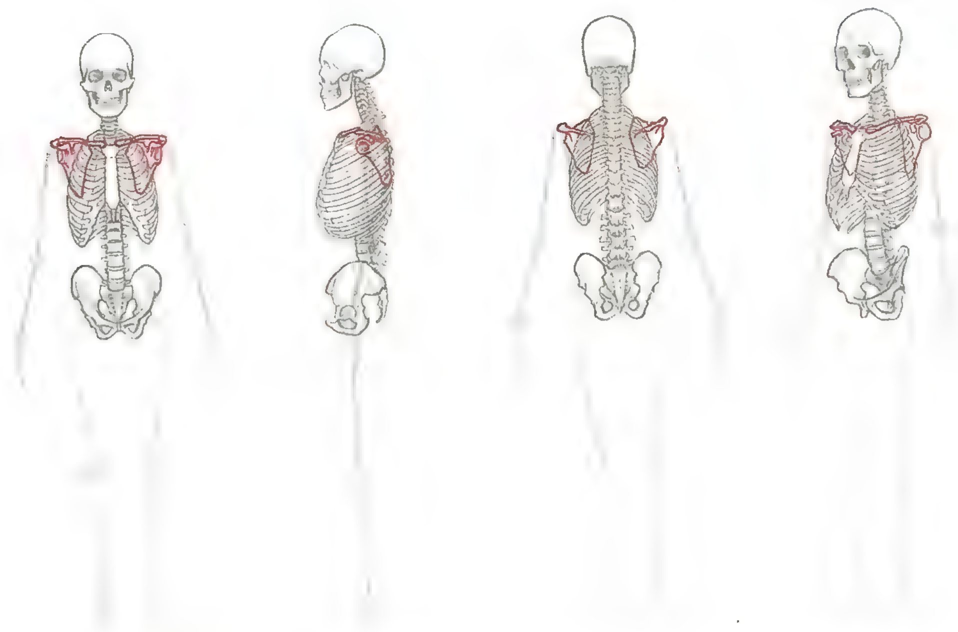


09. It's time to draw the vertebrae of the spinal column. Personally, I think this part is the most confusing and complex, but let's be patient and draw it step by step. Make sure the part overlapping with the thoracic cage is blurred.

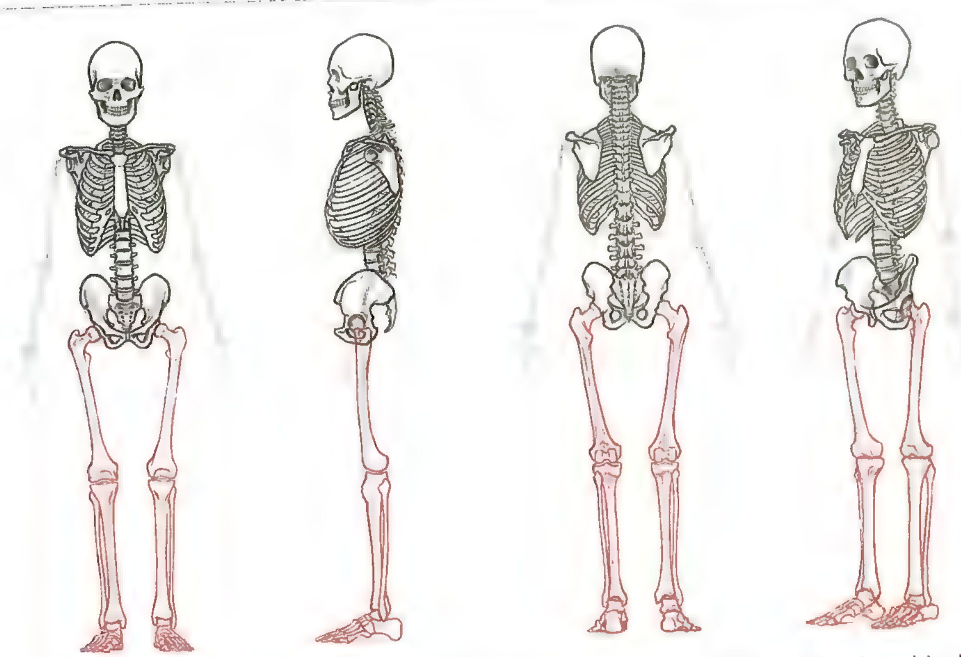
10. Connect the ribs, which start from the vertebrae, to the sternum. This part is also very confusing and complex, but it's much easier to draw if you first make a fine line in between the gaps in the ribs.



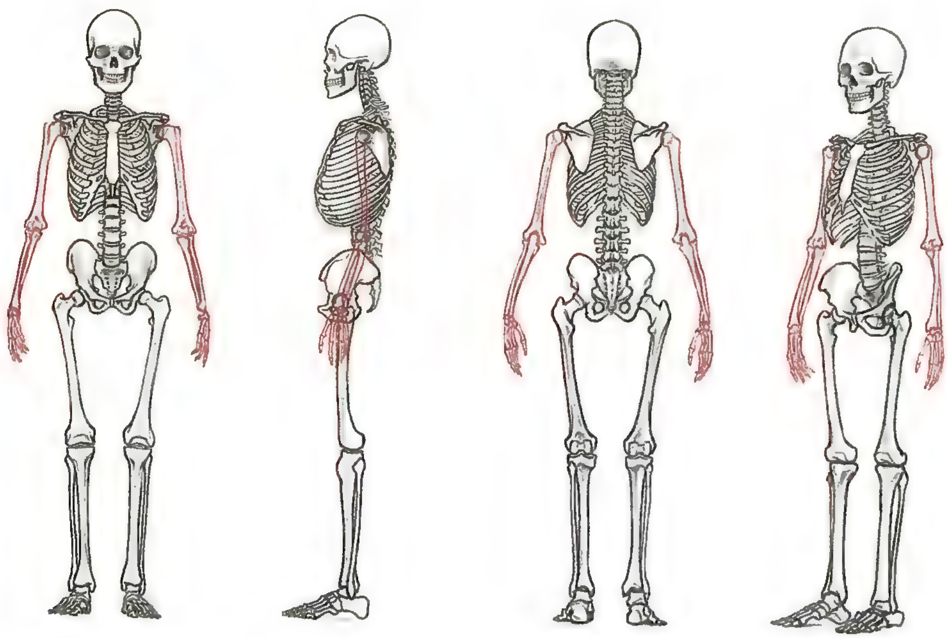
11. Draw the pelvis. The example above is a male pelvis, but if you are drawing a female pelvis, makes sure it is wider on the sides, and the pubic bone should be lower with the coccyx tilted slightly upwards.



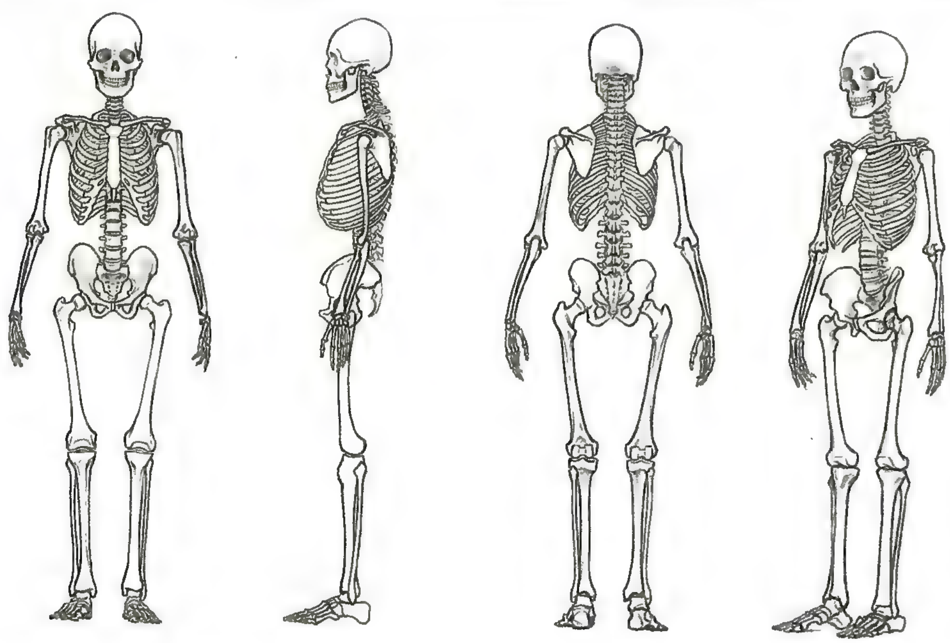
12. Describe the shoulder girdle by connecting the clavicle and scapula. The parts that overlap with the thoracic cage should be erased meticulously by using the fine edge of an eraser.



13. It's time to draw the leg bones. Starting off with the femur which starts at the 'socket' of the pelvis, draw the tibia, fibula and foot bones, in order.

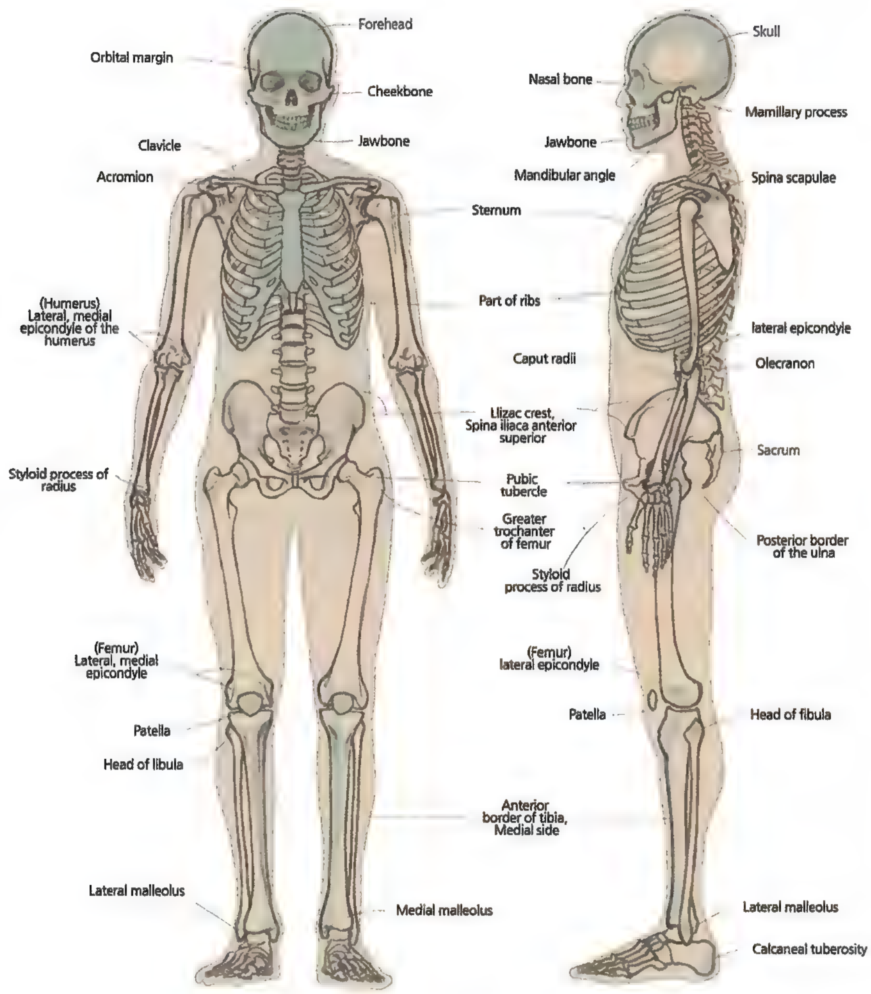


14. Last but not least, starting from the 'glenoid cavity' of the scapula, draw the humerus -> ulna -> radius -> hand bones, in that order. Here, we don't draw our forearms in anatomical position or in supination position. We draw them in the natural everyday position.

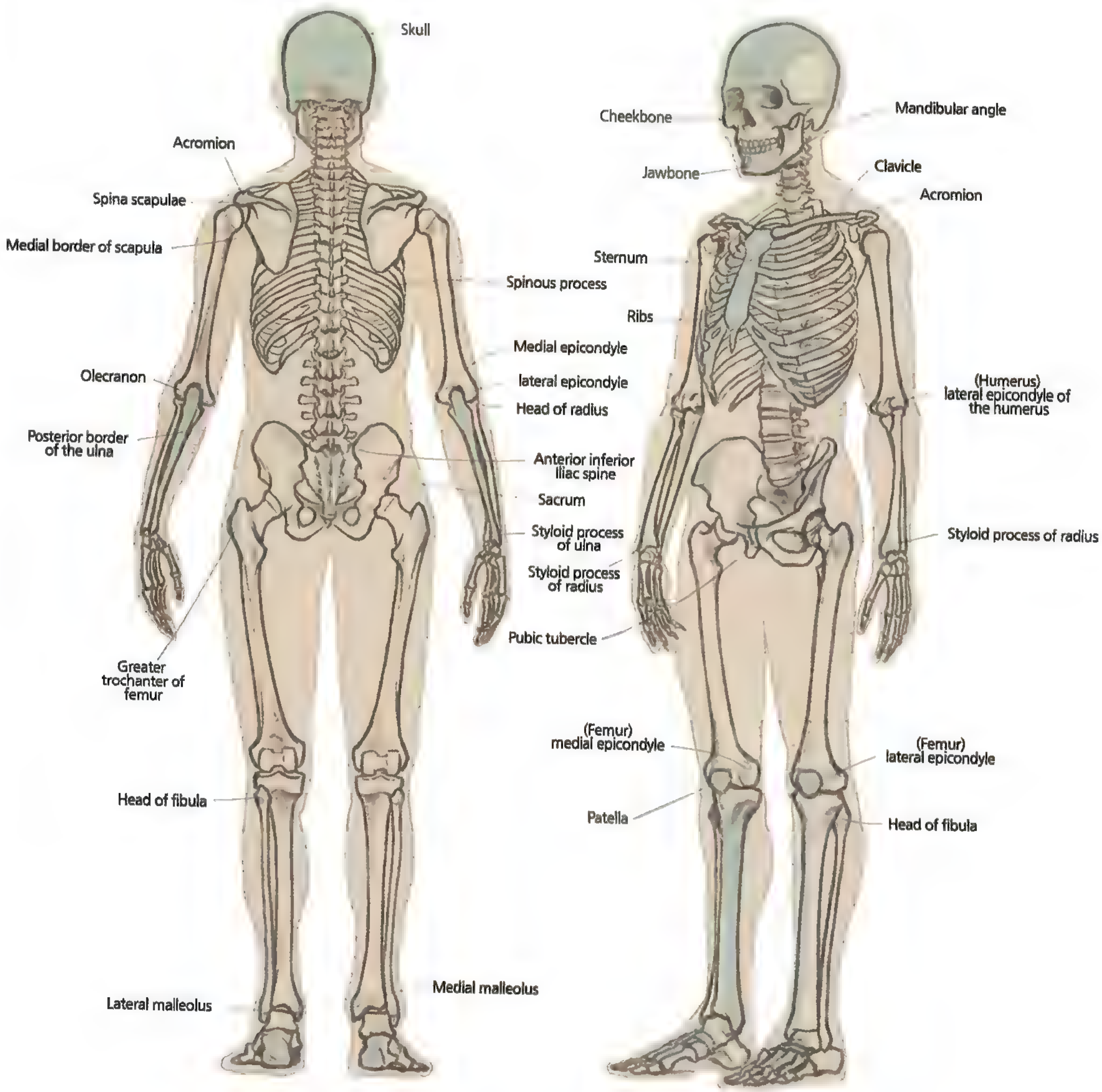


15. The skeleton is complete.

■Completed Figure of the Entire Skeleton



Let's put tracing paper on top of the skeleton we've drawn previously and create the actual outline of the human body. The parts colored in blue are areas visible on the surface or that can be identified by touch.



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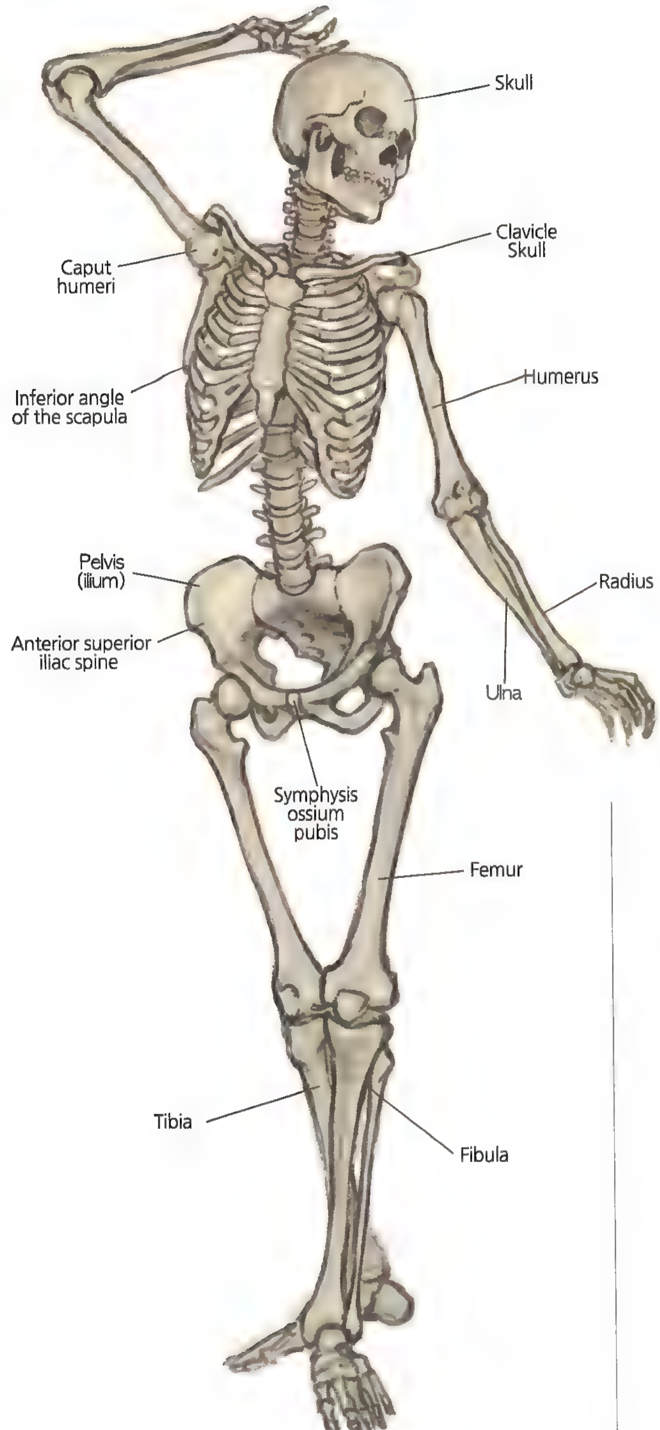
Drawing the Full Body Muscles

It's time to attach muscles to our entire body. As you may already know, unlike skeletons, muscles are very difficult to describe in one go. We have to attach muscles onto the basic skeletons from deep to superficial layers, in order. It's like as if you're molding something using clay.

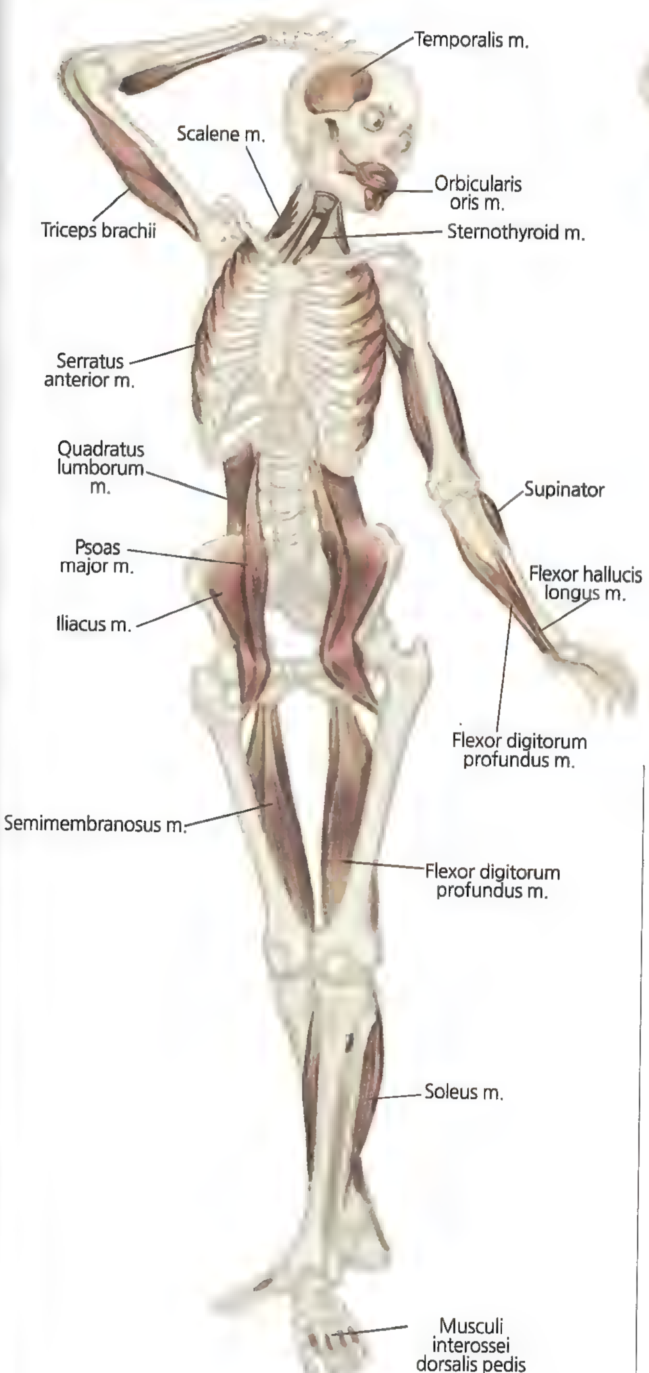


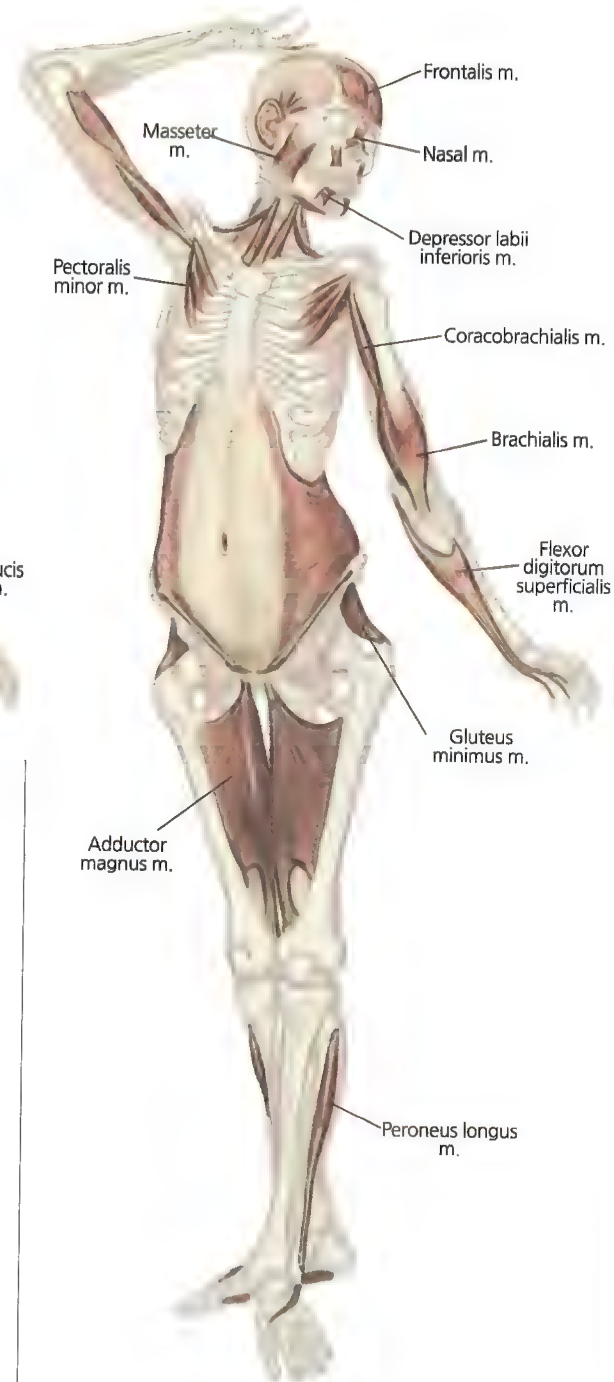
■ Basic Pose Anterior Side: Full Body of Female

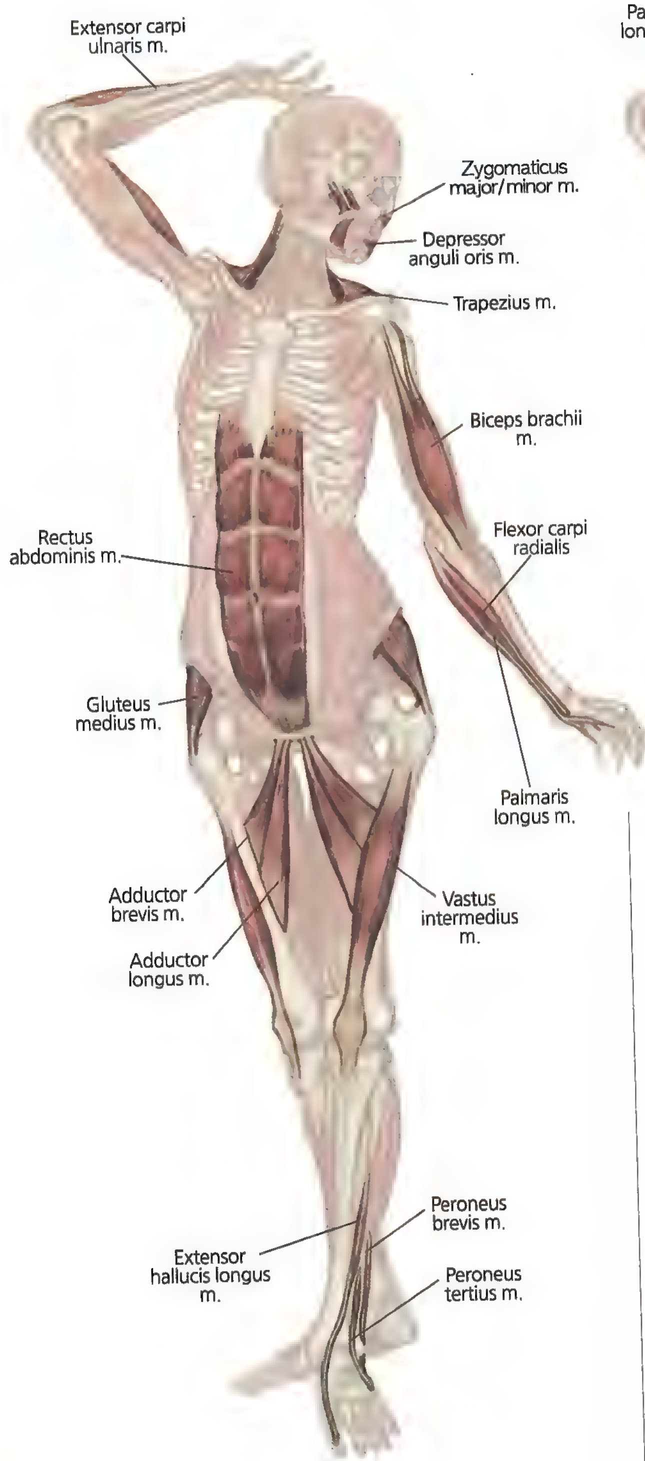
Rather than drawing a stiff posture, I've used all the tricks I've learned from drawing a skeleton to draw one striking a pose.

Now, I'm going to draw the muscles I've learned earlier. I will add them in order, from the deep to the superficial layers. I will show this change by overlapping them I won't give any additional explanation. It is sufficient to just go over the shapes and names of individual muscles, as we'll go over them again later.

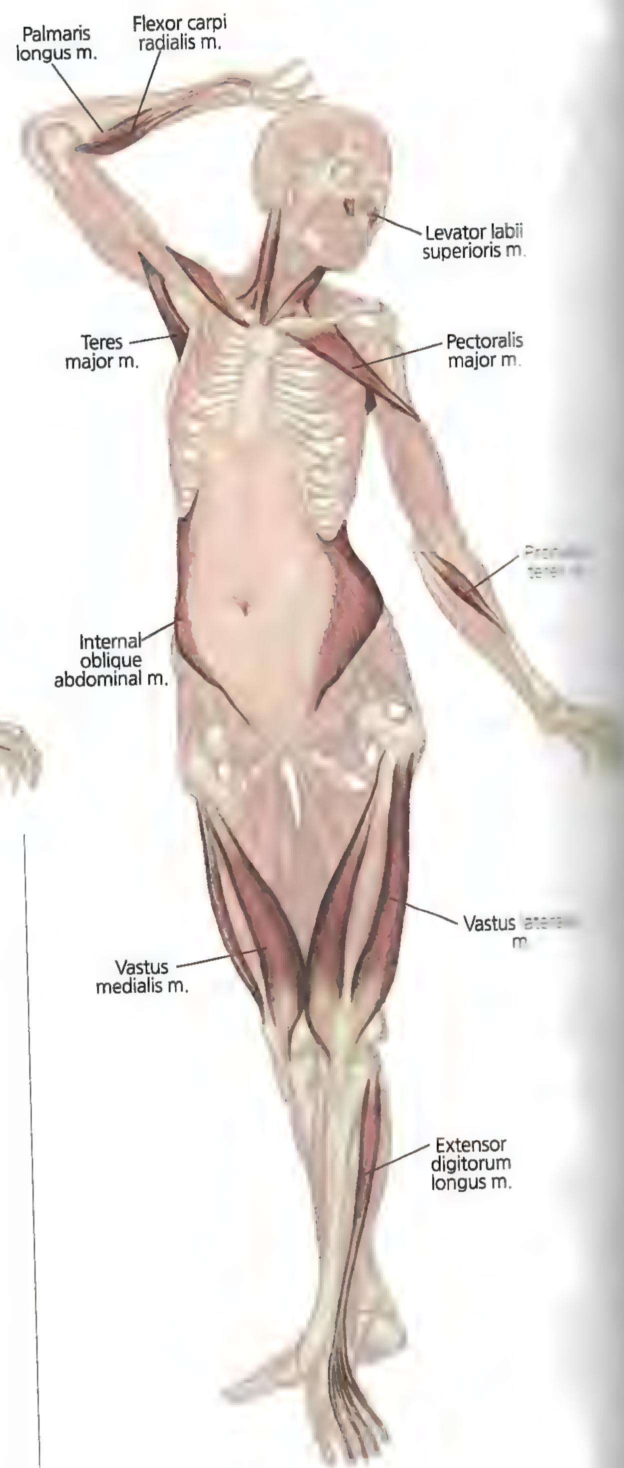
It's not going to be easy, but let's attach the muscles one by one.


Temporalis m.
Scalene m.
Orbicularis oris m.
Triceps brachii
Sternothyroid m.
Serratus anterior m.
Quadratus lumborum m.
Supinator
Psoas major m.
Flexor hallucis longus m.
Iliacus m.
Flexor digitorum profundus m.
Semimembranosus m.
Flexor digitorum profundus m.
Soleus m.
Musculi interossei dorsalis pedis

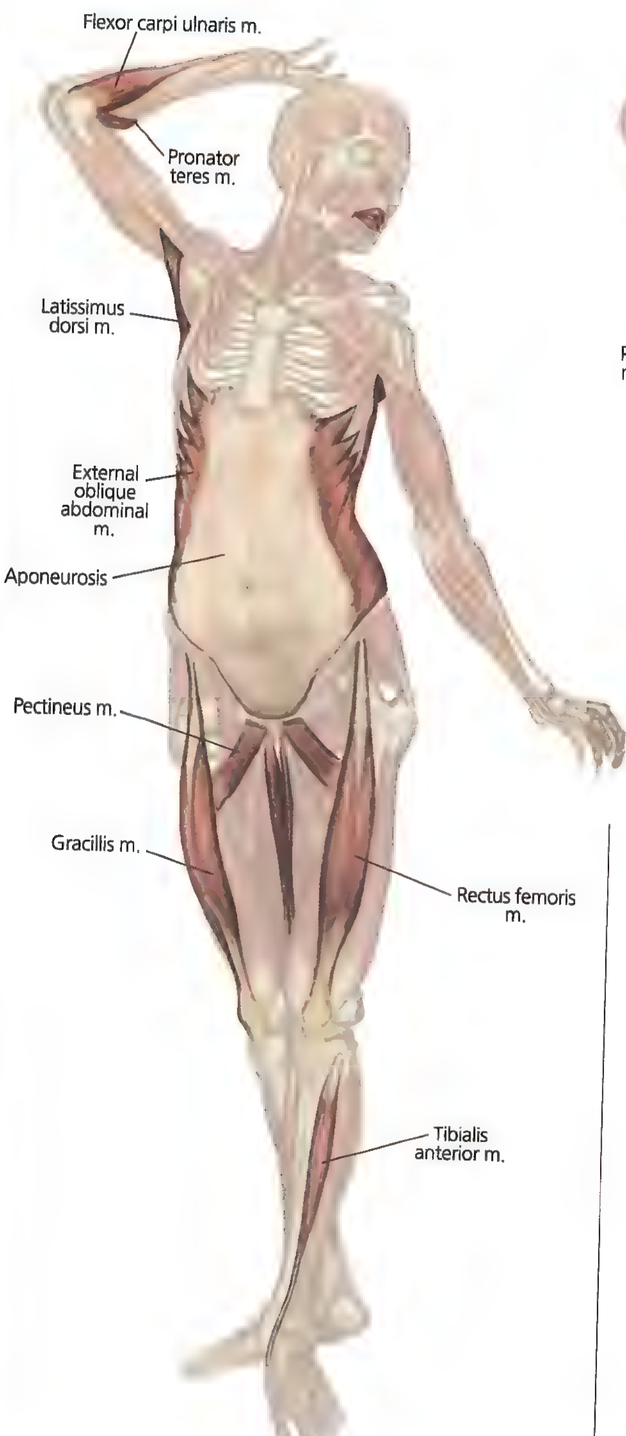

Frontalis m.
Masseter m.
Nasal m.
Depressor labii inferioris m.
Pectoralis minor m.
Coracobrachialis m.
Brachialis m.
Flexor digitorum superficialis m.
Gluteus minimus m.
Adductor magnus m.
Peroneus longus m.

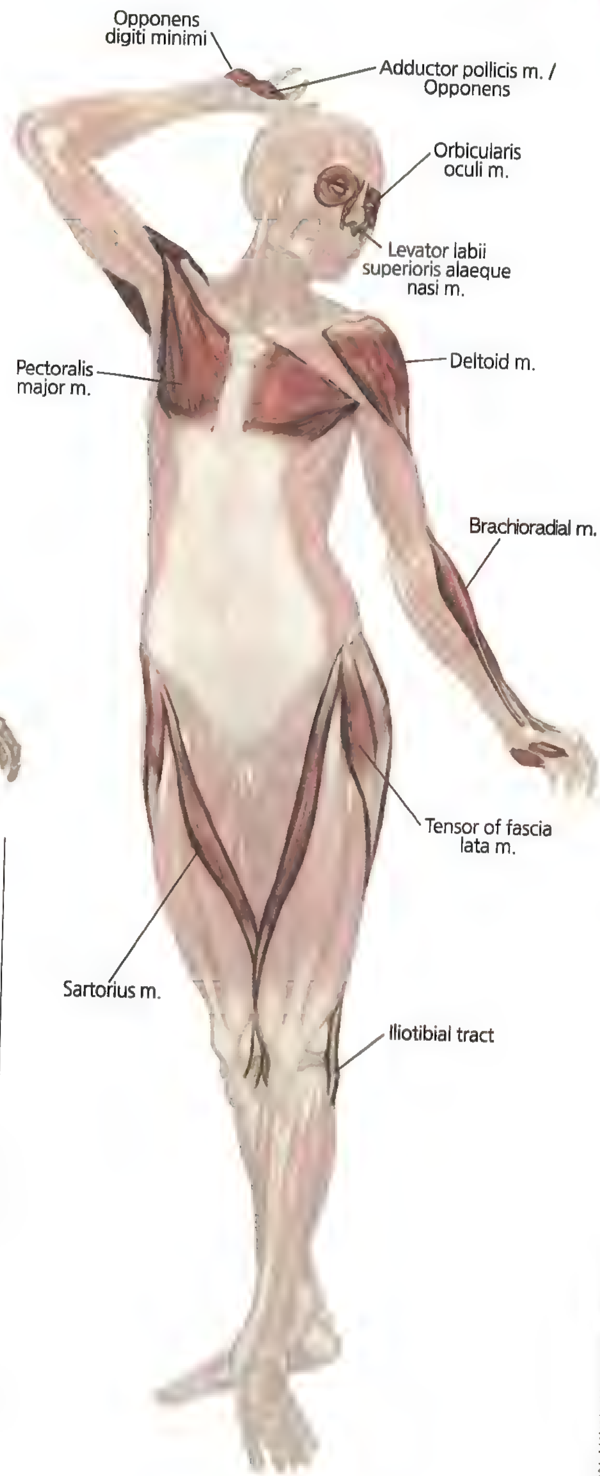


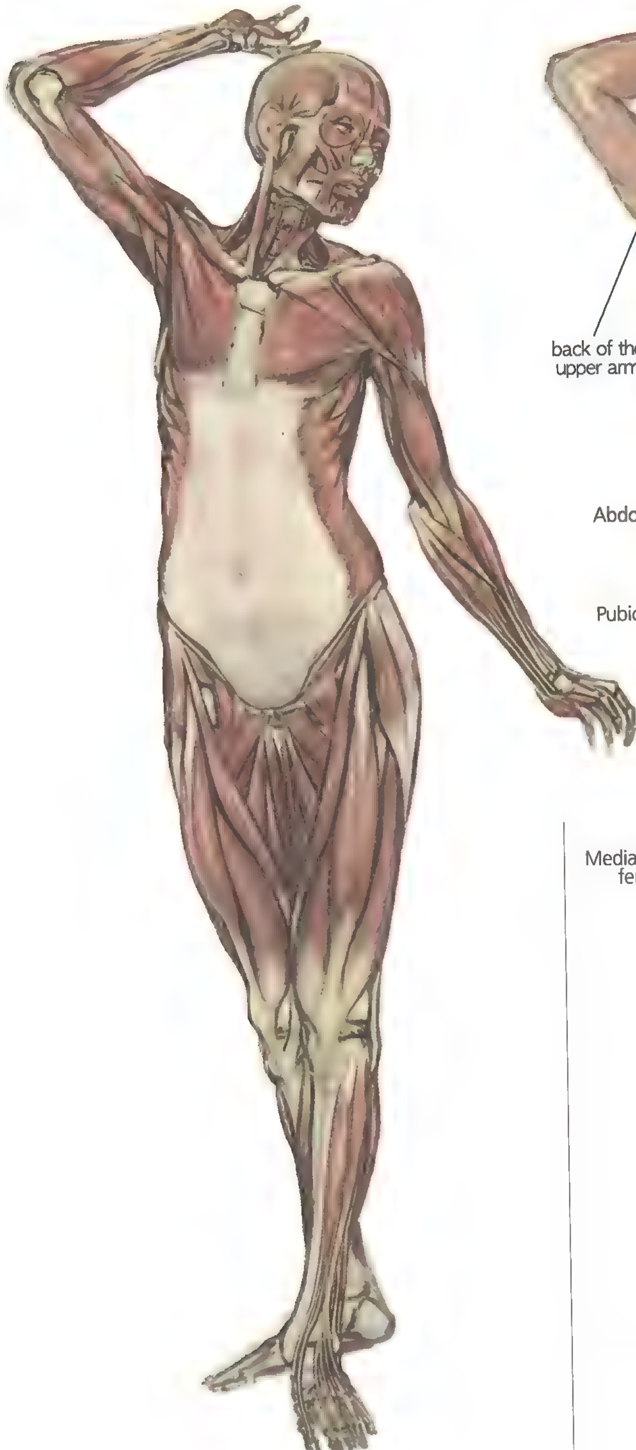
Extensor carpi ulnaris m.
Zygomaticus major/minor m.
Depressor anguli oris m.
Trapezius m.
Biceps brachii m.
Rectus abdominis m.
Flexor carpi radialis
Gluteus medius m.
Palmaris longus m.
Adductor brevis m.
Vastus intermedius m.
Adductor longus m.
Peroneus brevis m.
Extensor hallucis longus m.
Peroneus tertius m.



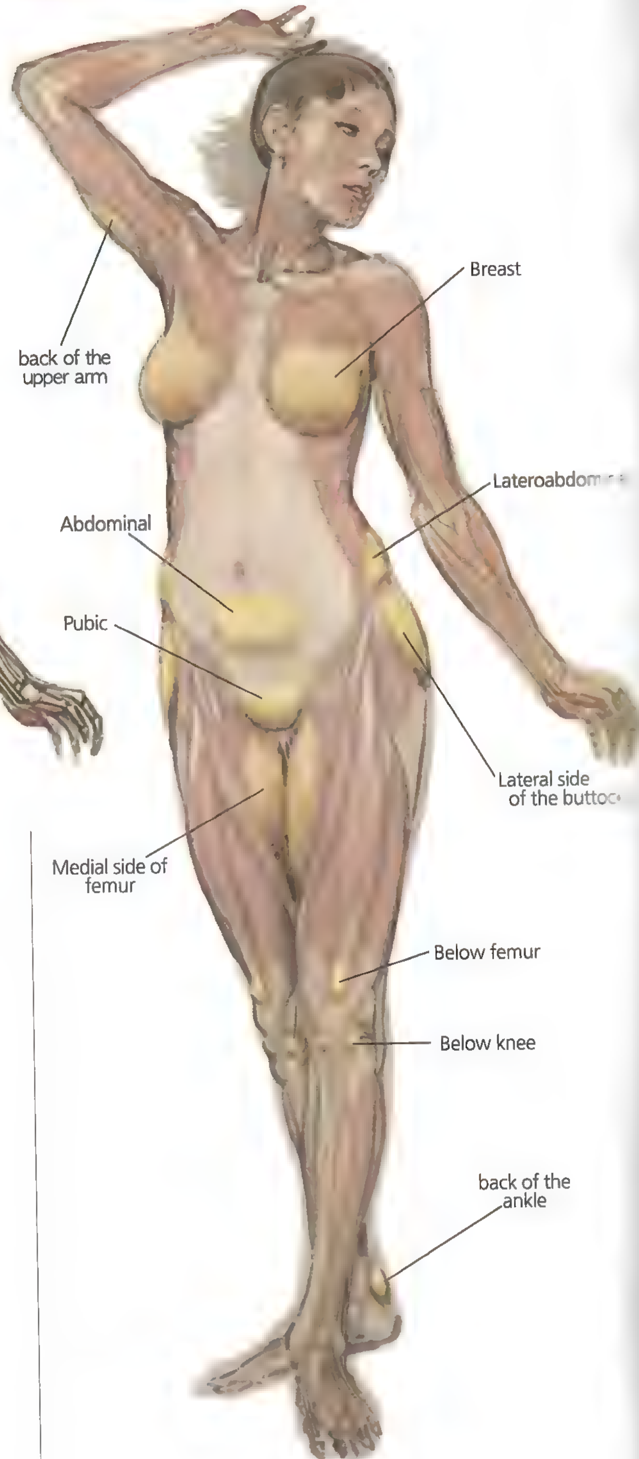
Palmaris longus m.
Flexor carpi radialis m.
Levator labii superioris m.
Teres major m.
Pectoralis major m.
Internal oblique abdominal m.
Vastus
Vastus medialis m.
Extensor digitorum longus m.


Flexor carpi ulnaris m.
Pronator teres m.
Latissimus dorsi m.
External oblique abdominal m.
Aponeurosis
Pectineus m.
Gracillis m.
Rectus femoris m.
Tibialis anterior m.


Opponens digiti minimi
Adductor pollicis m. / Opponens
Orbicularis oculi m.
Levator labii superioris alaeque nasi m.
Pectoralis major m.
Deltoid m.
Brachioradial m.
Tensor of fascia lata m.
Sartorius m.
Iliotibial tract



Layer of Fat Distribution



■ Basic Pose Posterior Side: Full body of a Male

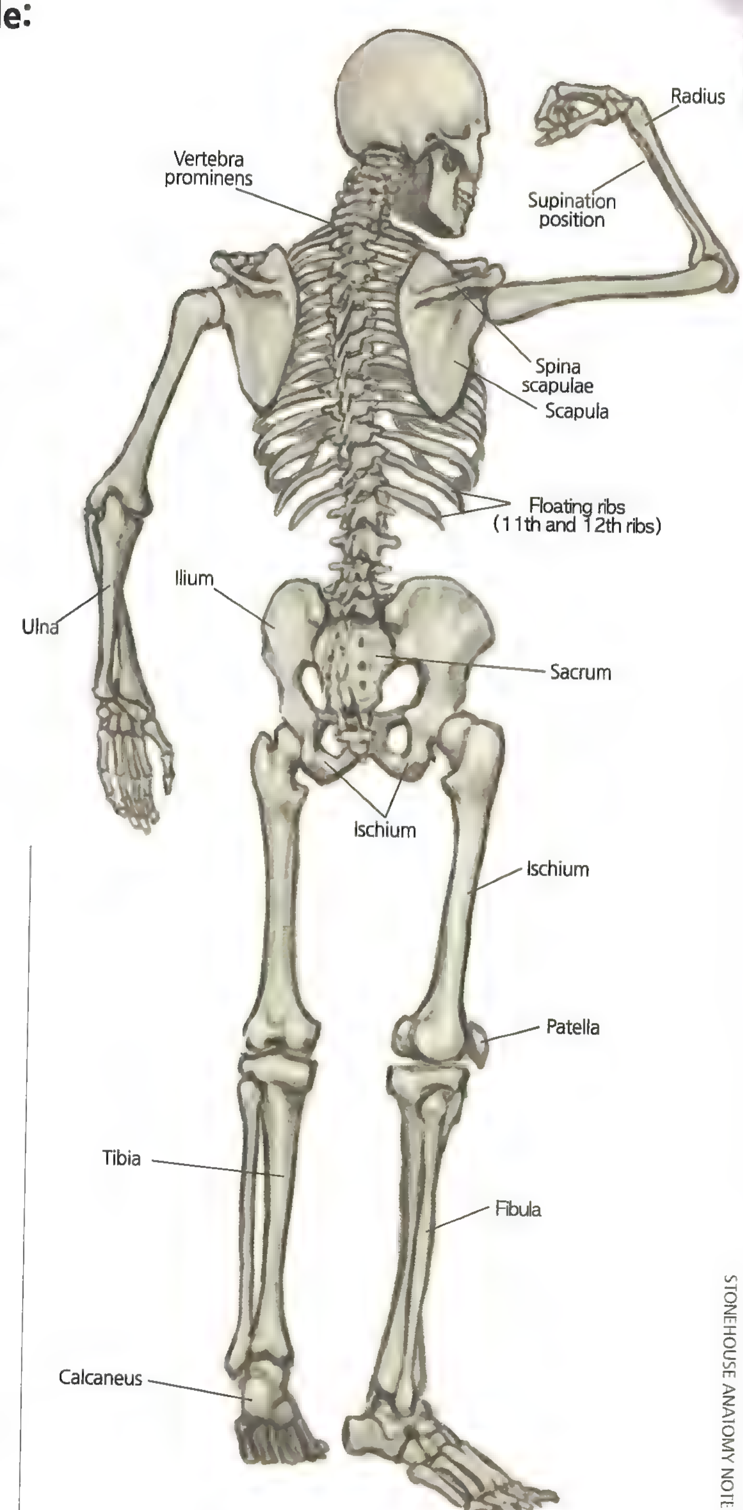
It's time to draw the posterior side.

I've decided to use a male character for the posterior side. Personally, I think the back of a male looks more impressive than the front and also the back muscles of males are more likely to be depicted as being more developed than that of females.

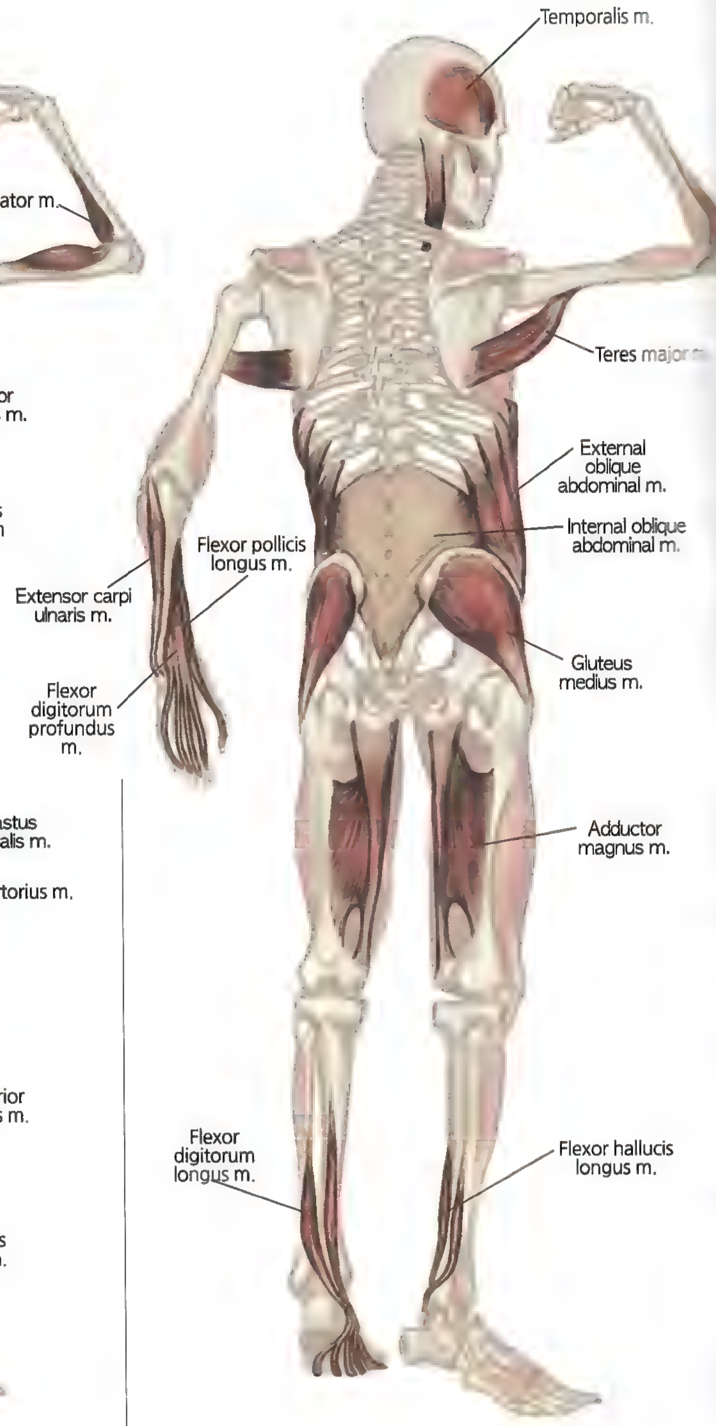
In the case of the male skeleton, the pelvis is smaller and thoracic cage is bigger than that of a females. The outline of the skeleton is more linear, so it may appear stiff overall. On top of that, drawing the posterior side is trickier because of the complex vertebrae and pelvis.

However, once you're done attaching the muscles, this exercise will give you a sense of great accomplishment.

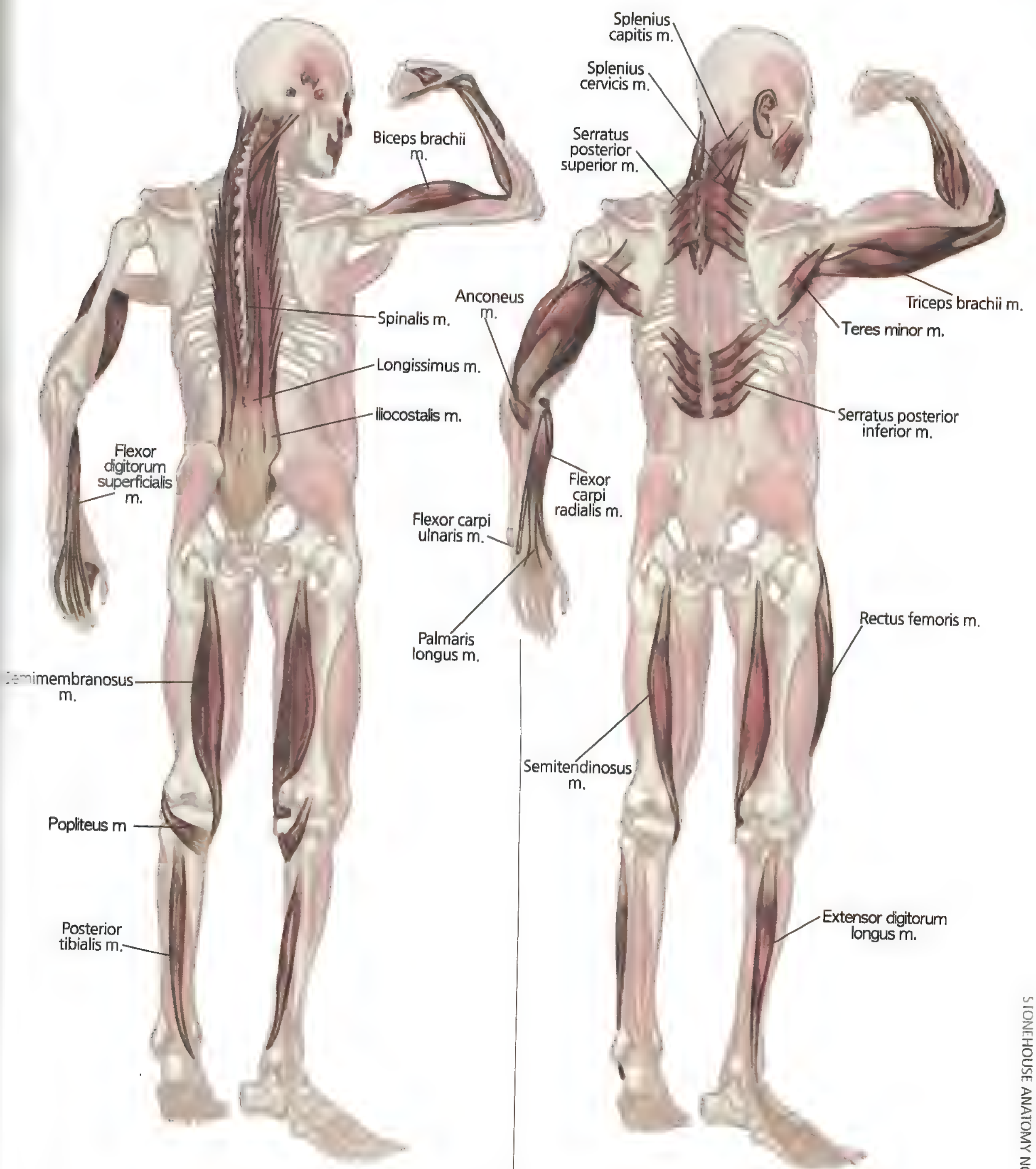
First, carefully check the points shown in the picture.

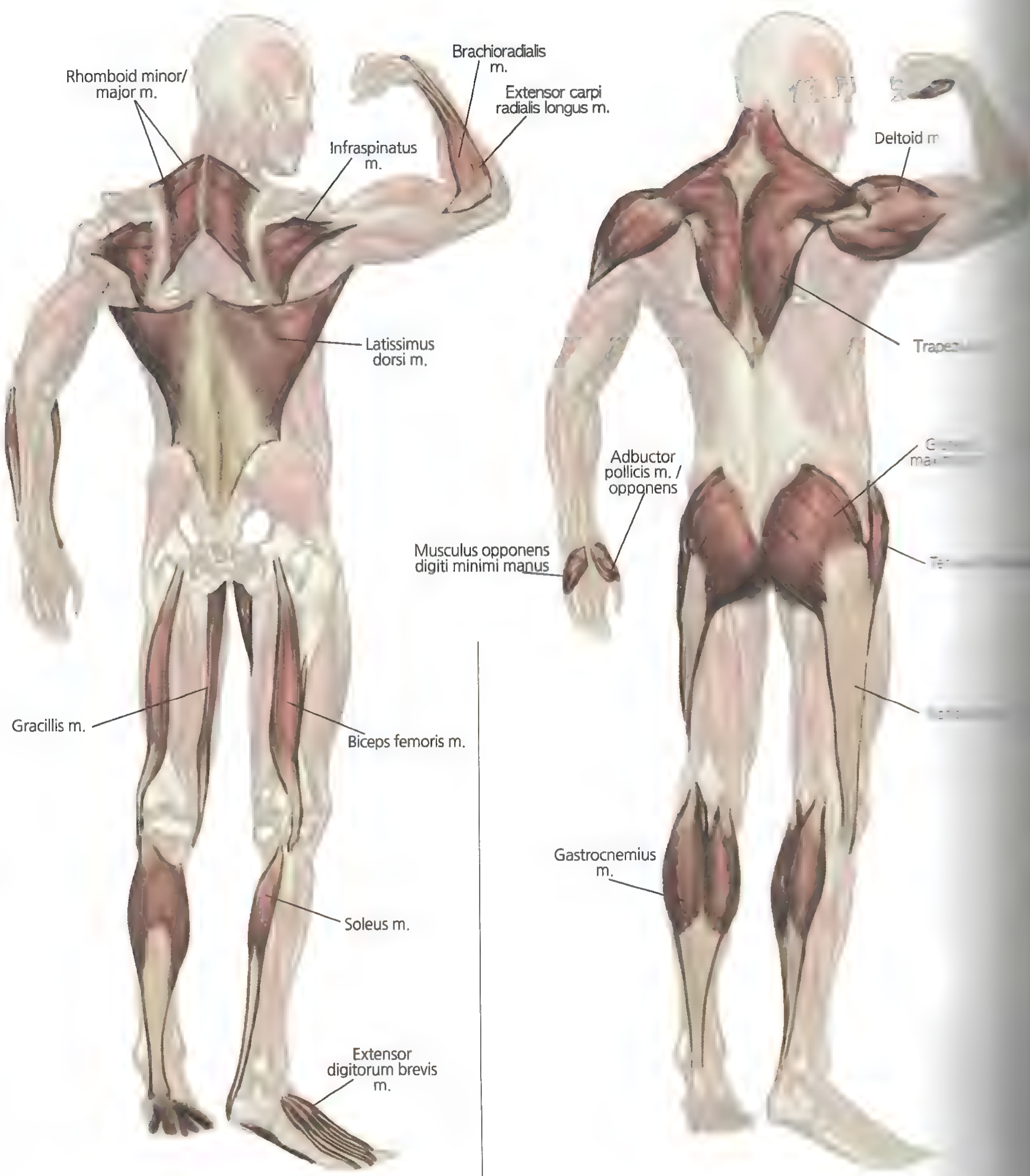


Supraspinatus m.
Supinator m.
Anterior serratus m.
Brachialis m.
Quadratus Lumborum m.
Gluteus Minimus
Adductor brevis m.
Vastus lateralis m.
Adductor longus m.
Sartorius m.
Vastus medialis m.
Extensor digitorum longus m.
Anterior tibialis m.
Peroneus tertius m.



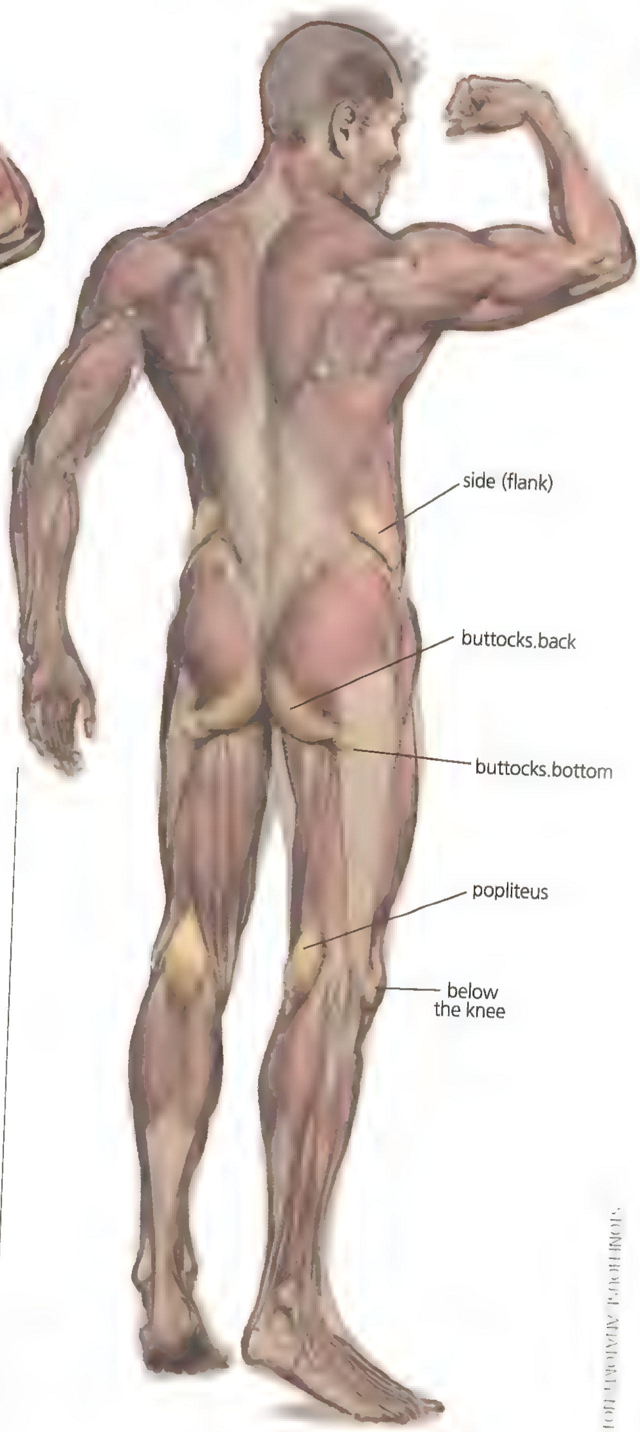
Temporalis m.
Teres major
External oblique abdominal m.
Internal oblique abdominal m.
Flexor pollicis longus m.
Extensor carpi ulnaris m.
Gluteus medius m.
Flexor digitorum profundus m.
Adductor magnus m.
Flexor digitorum longus m.
Flexor hallucis longus m.


Biceps brachii m.
Spinalis m.
Longissimus m.
Iliocostalis m.
Flexor digitorum superficialis m.
Semimembranosus m.
Popliteus m
Posterior tibialis m.
Anconeus m.
Flexor carpi ulnaris m.
Palmaris longus m.
Flexor carpi radialis m.
Splenius capitis m.
Splenius cervicis m.
Serratus posterior superior m.
Triceps brachii m.
Teres minor m.
Serratus posterior inferior m.
Rectus femoris m.
Semitendinosus m.
Extensor digitorum longus m.



Rhomboid minor/ major m.
Brachioradialis m.
Extensor carpi radialis longus m.
Infraspinatus m.
Latissimus dorsi m.
Gracilis m.
Biceps femoris m.
Soleus m.
Extensor digitorum brevis m.
Deltoid m
Adductor pollicis m. / opponens
Musculus opponens digiti minimi manus
Gastrocnemius m.

●Layer of fat distribution area

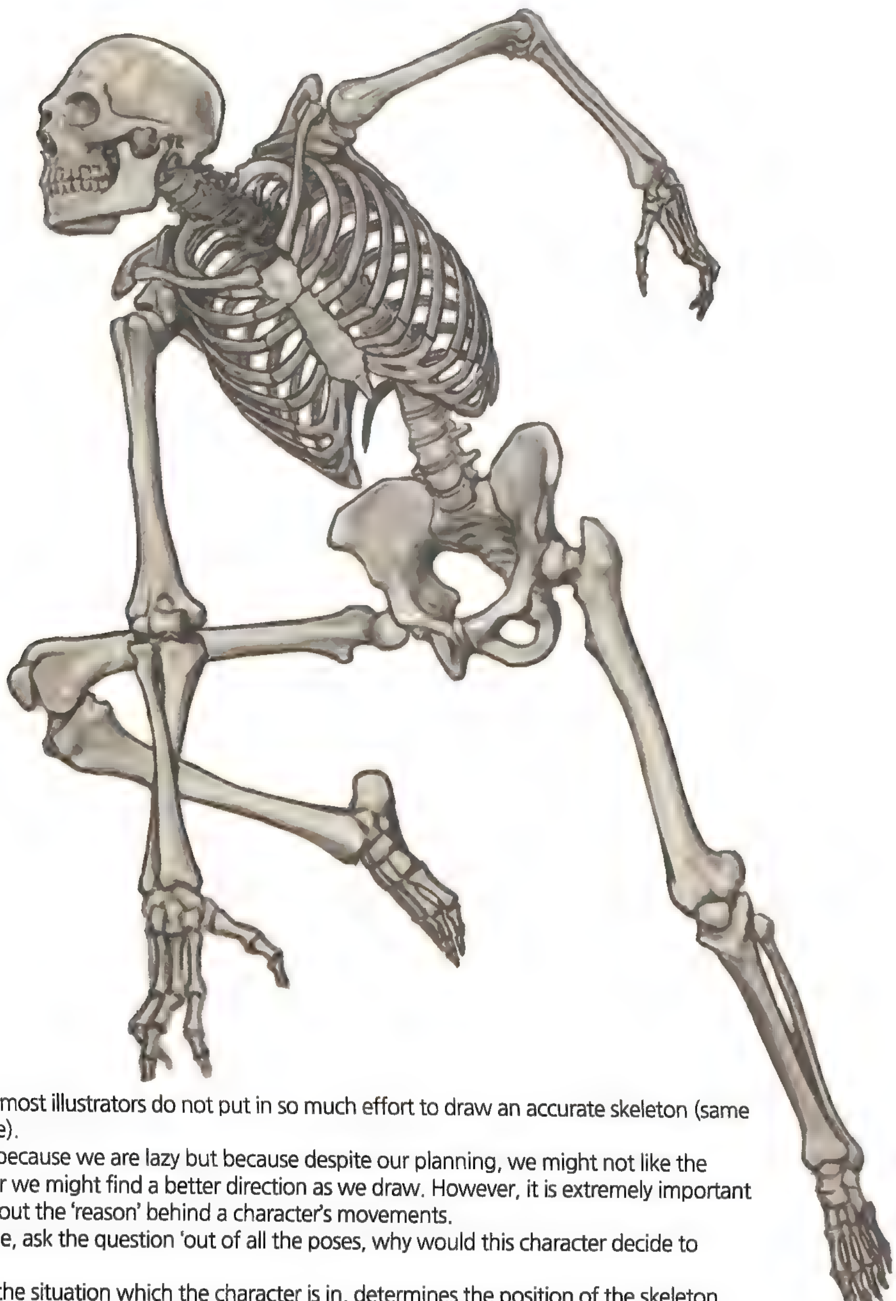


■Applied Pose Anterior Side - Full Body of Male 2

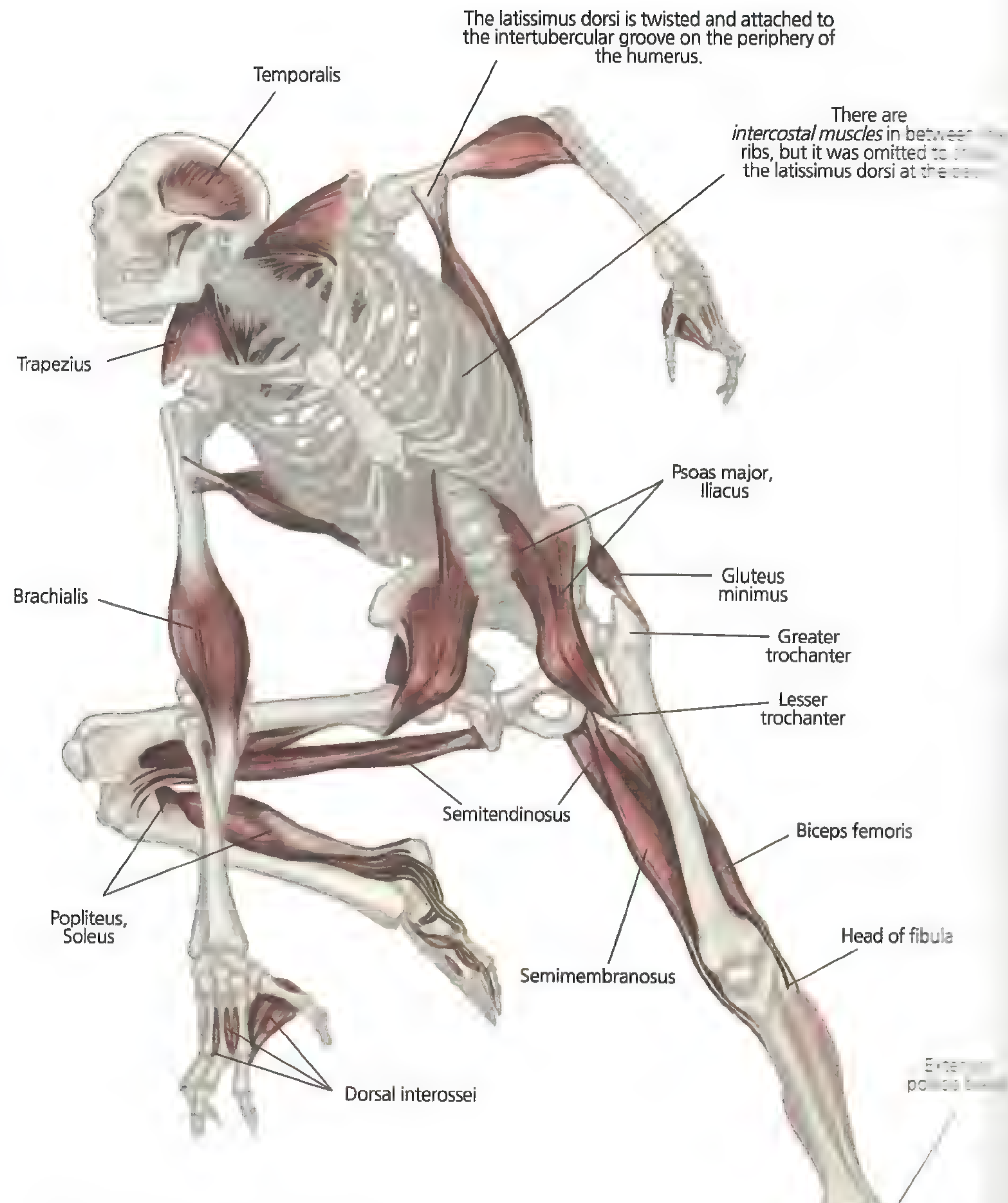
Since we are done with warming up, let's do a final review of what we've studied by drawing an illustration of a more dynamic sci-fi character. As this is the highlight of the book, take your time to follow along as you revisit the content we've studied together.

01. This is the final destination for drawing characters. This is a completed version of a virtual nude figure, where I drew individual muscles and skin on top of the skeleton.
Of course, it would be so much better if an actual model were posing in front of me with no clothes on. However, because we can't do that, we must utilize all the anatomical knowledge we learned before in order to create a realistic character.

02. It is difficult to draw a full body skeleton that is doing a complex movement. First, we have to overcome the stereotyped image we have about the appearance of skeletons. The second and biggest reason is that it's almost impossible to identify the correct answer. So, it's important that the person drawing has a good understanding of the first basic pose. For instance, he or she must be mindful of things like which direction does the palm face, which direction does the tip of the nose face, and the angle between the pubic symphysis and sternum etc.

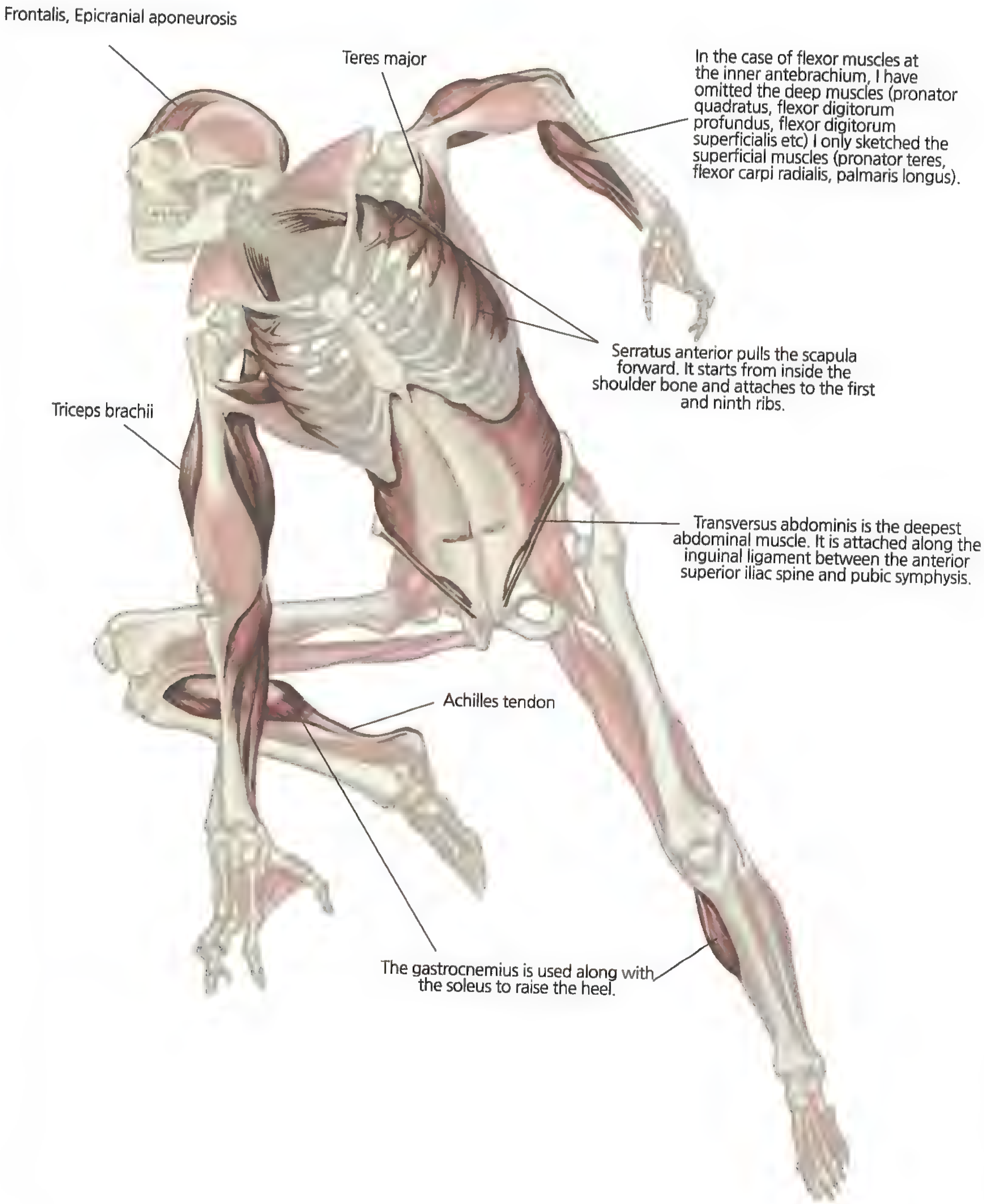


03. Of course, most illustrators do not put in so much effort to draw an accurate skeleton (same goes for me).
This is not because we are lazy but because despite our planning, we might not like the outcome or we might find a better direction as we draw. However, it is extremely important to think about the 'reason' behind a character's movements.
For example, ask the question 'out of all the poses, why would this character decide to jump?'
Imagining the situation which the character is in, determines the position of the skeleton which ultimately determines all movements.

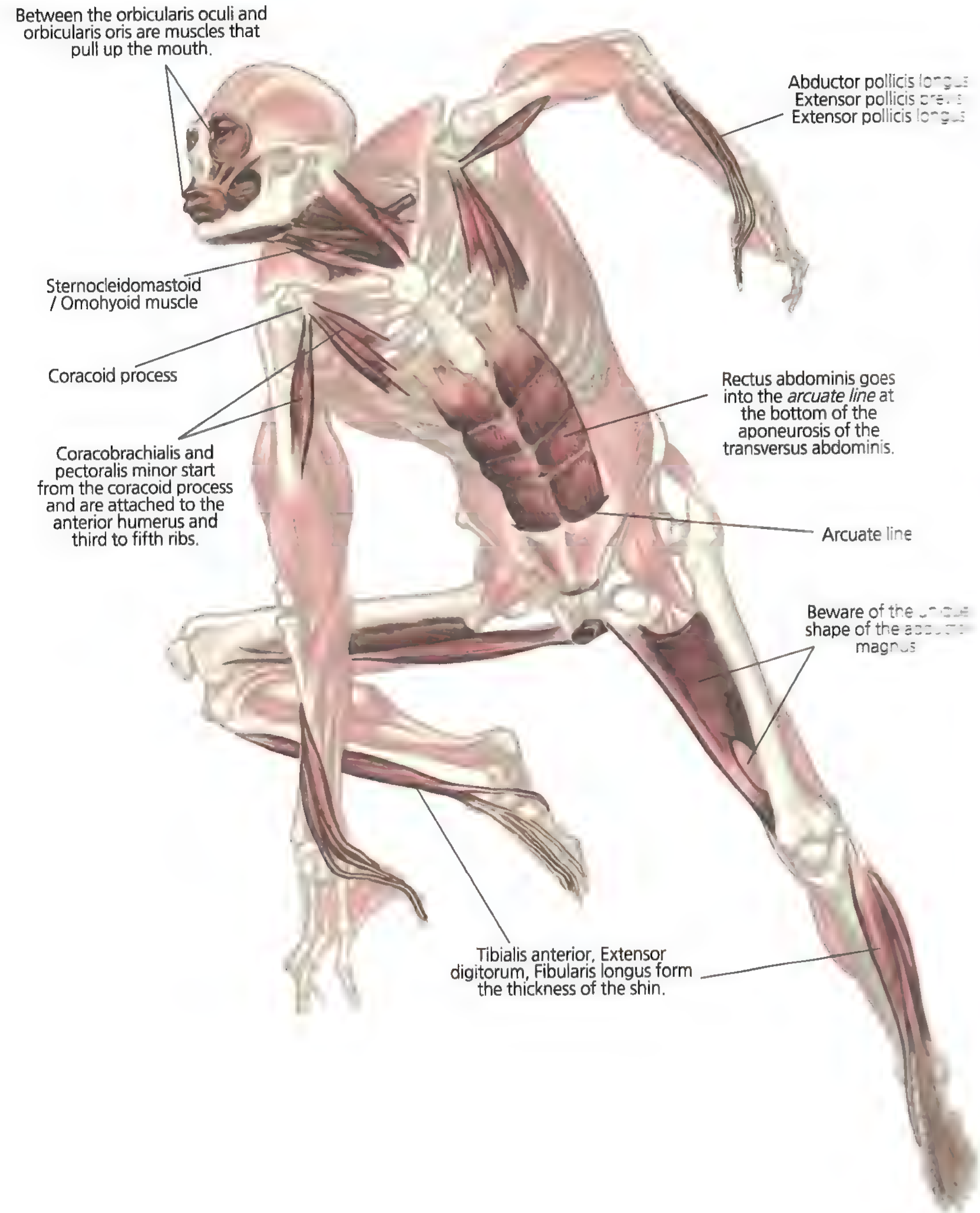


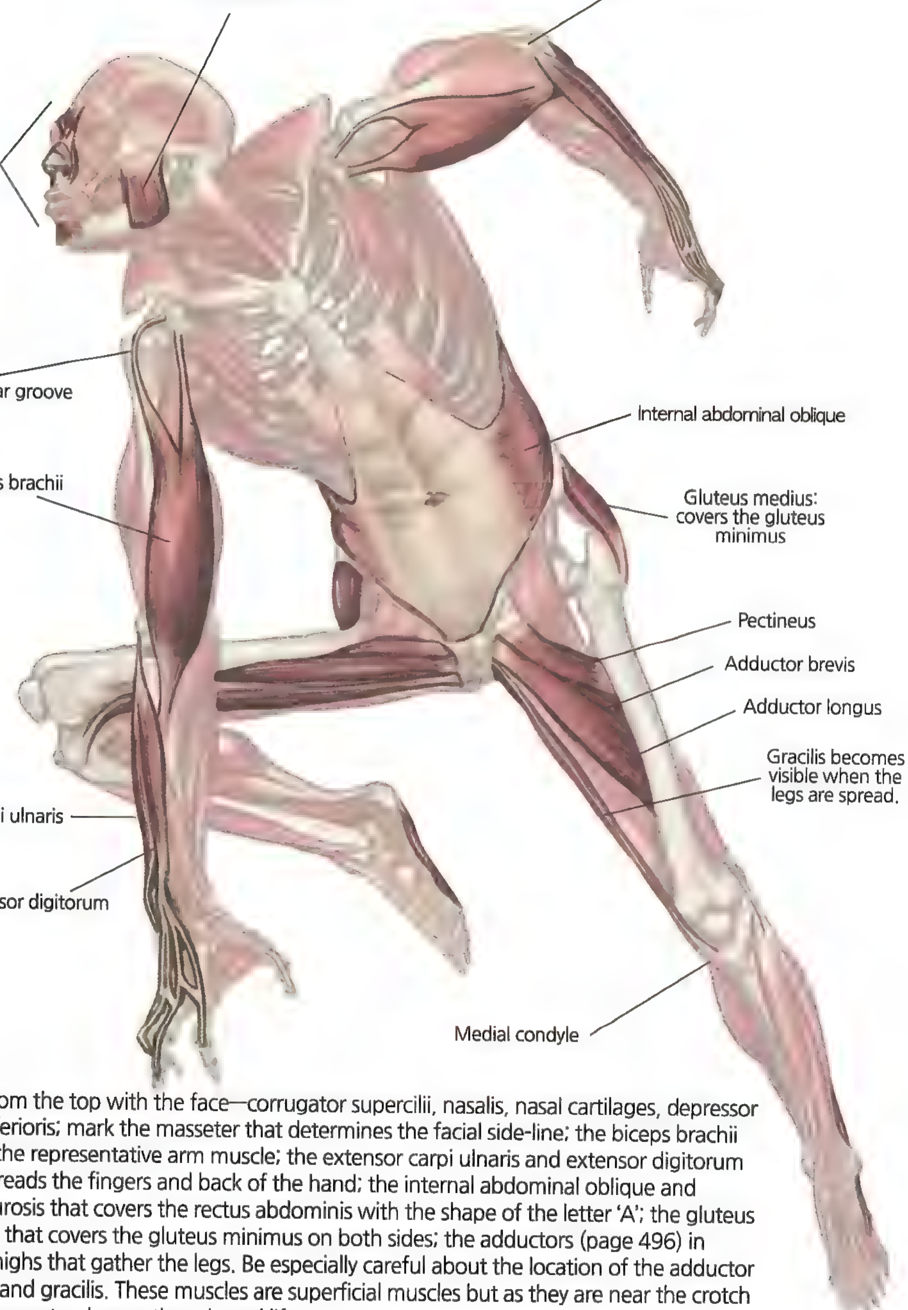
04. Once you have a good drawing of the skeletal structure, adding on muscles will be like putting together pieces of a puzzle. I have already emphasized several times that the muscles are attached to the skeletal structure. Based on the skeletal structure, all you need to do is mark the end points and fill in the middle. It is true that there are many muscles, but we will first try to draw the deepest muscles at the back that are hidden by the skeletal structure.

05. Things start to get a little complicated at this stage. Although most of the deep muscles are covered by superficial muscles, the *serratus anterior* and *teres major* on each side of the thoracic skeleton become visible when the arms are raised, so they should not be omitted.

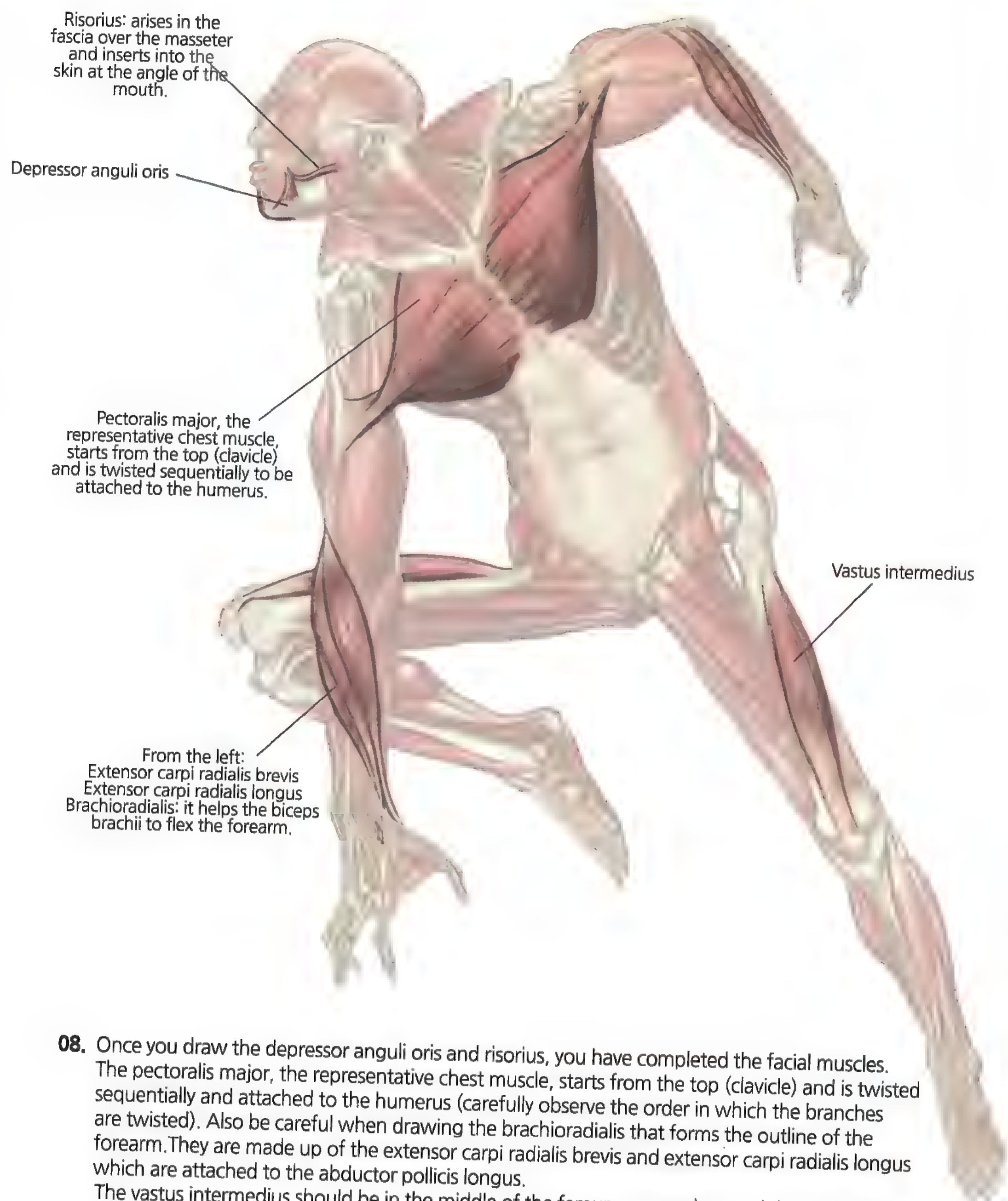


06. Start with the orbicularis oculi and orbicularis oris, which are major facial muscles. Continue with the sternocleidomastoid, the coracobrachialis which is visible under the armpit when the arm is raised, the pectoralis minor inside the chest, and abductor pollicis (page 359) that oversees thumb movement, the adductor magnus inside the thigh, and the tibial muscles (page 501) that form the inner curves of the shin.



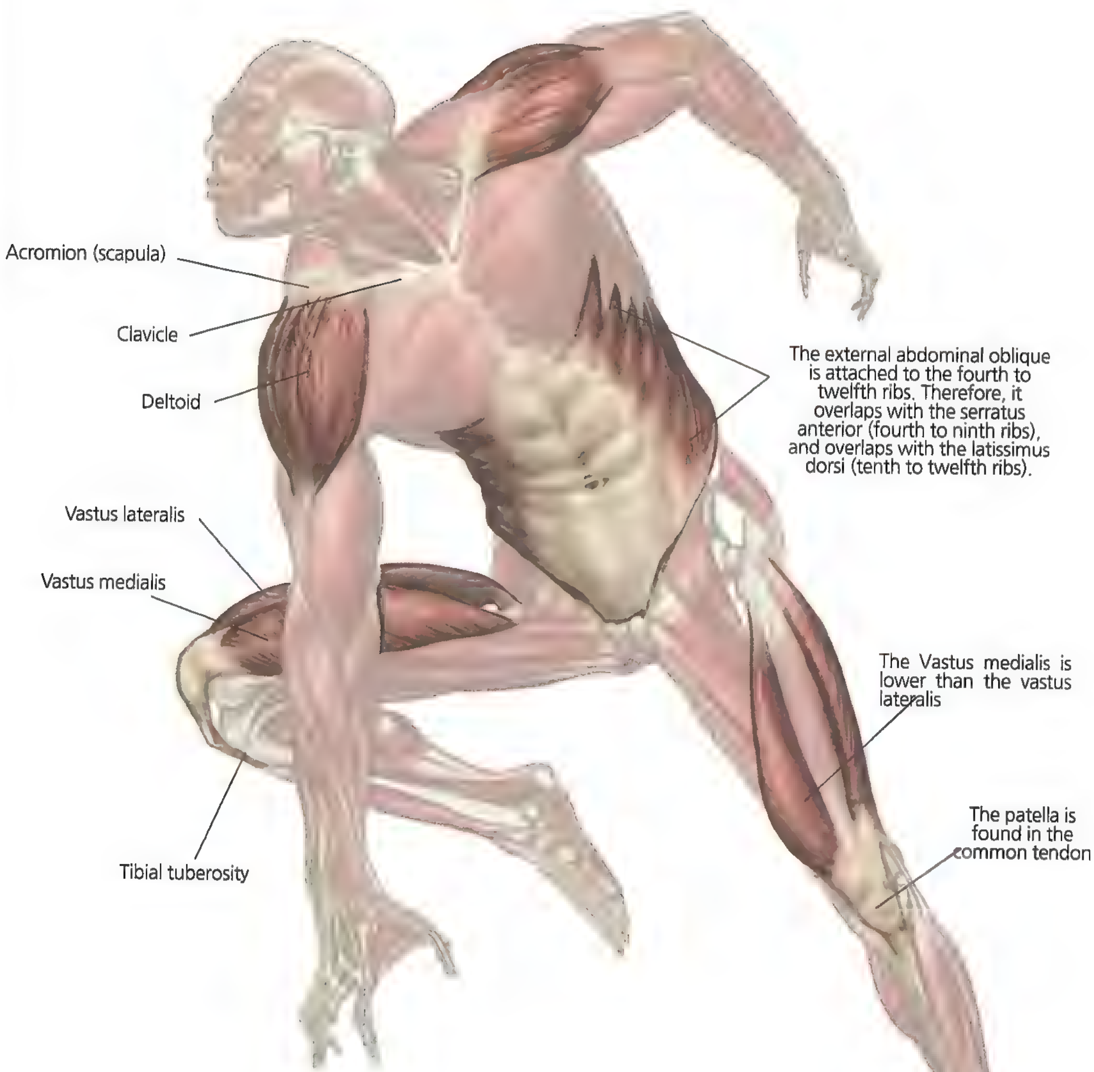


07. Start from the top with the face—corrugator supercilii, nasalis, nasal cartilages, depressor labii inferioris; mark the masseter that determines the facial side-line; the biceps brachii that is the representative arm muscle; the extensor carpi ulnaris and extensor digitorum that spreads the fingers and back of the hand; the internal abdominal oblique and aponeurosis that covers the rectus abdominis with the shape of the letter 'A'; the gluteus medius that covers the gluteus minimus on both sides; the adductors (page 496) in inner thighs that gather the legs. Be especially careful about the location of the adductor longus and gracilis. These muscles are superficial muscles but as they are near the crotch it is not easy to observe them in real life.



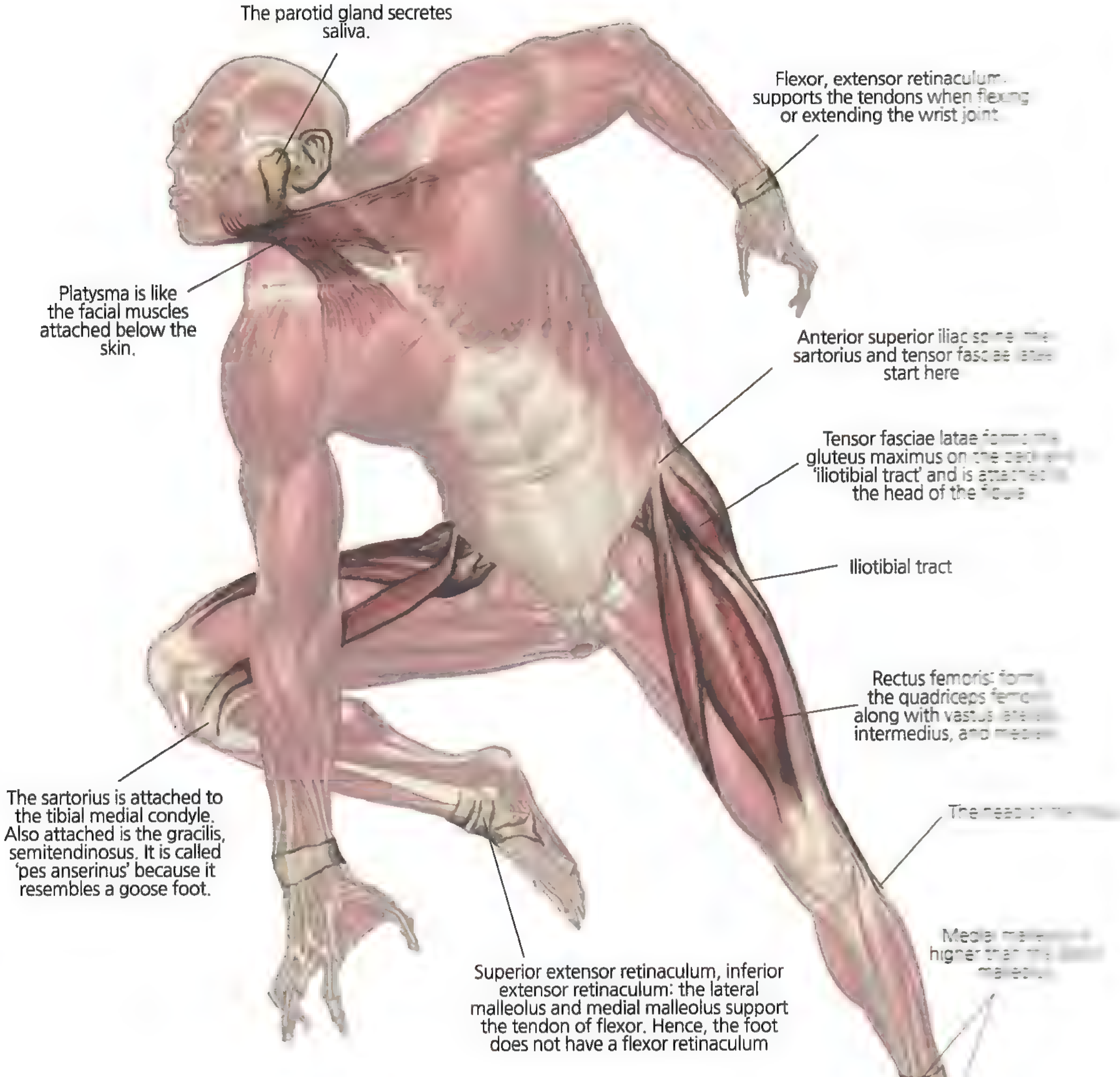
08. Once you draw the depressor anguli oris and risorius, you have completed the facial muscles. The pectoralis major, the representative chest muscle, starts from the top (clavicle) and is twisted sequentially and attached to the humerus (carefully observe the order in which the branches are twisted). Also be careful when drawing the brachioradialis that forms the outline of the forearm.They are made up of the extensor carpi radialis brevis and extensor carpi radialis longus which are attached to the abductor pollicis longus.
The vastus intermedius should be in the middle of the femur, wrapped around the thigh (page 497).

09. The uppermost deltoid simultaneously holds the clavicle and scapula. The external abdominal oblique in the middle of the body trunk is clasped to the serratus anterior. They are widely known muscles and not difficult to draw. The point is to sketch the curves of the muscular fiber as they are superficial muscles close to the skin.



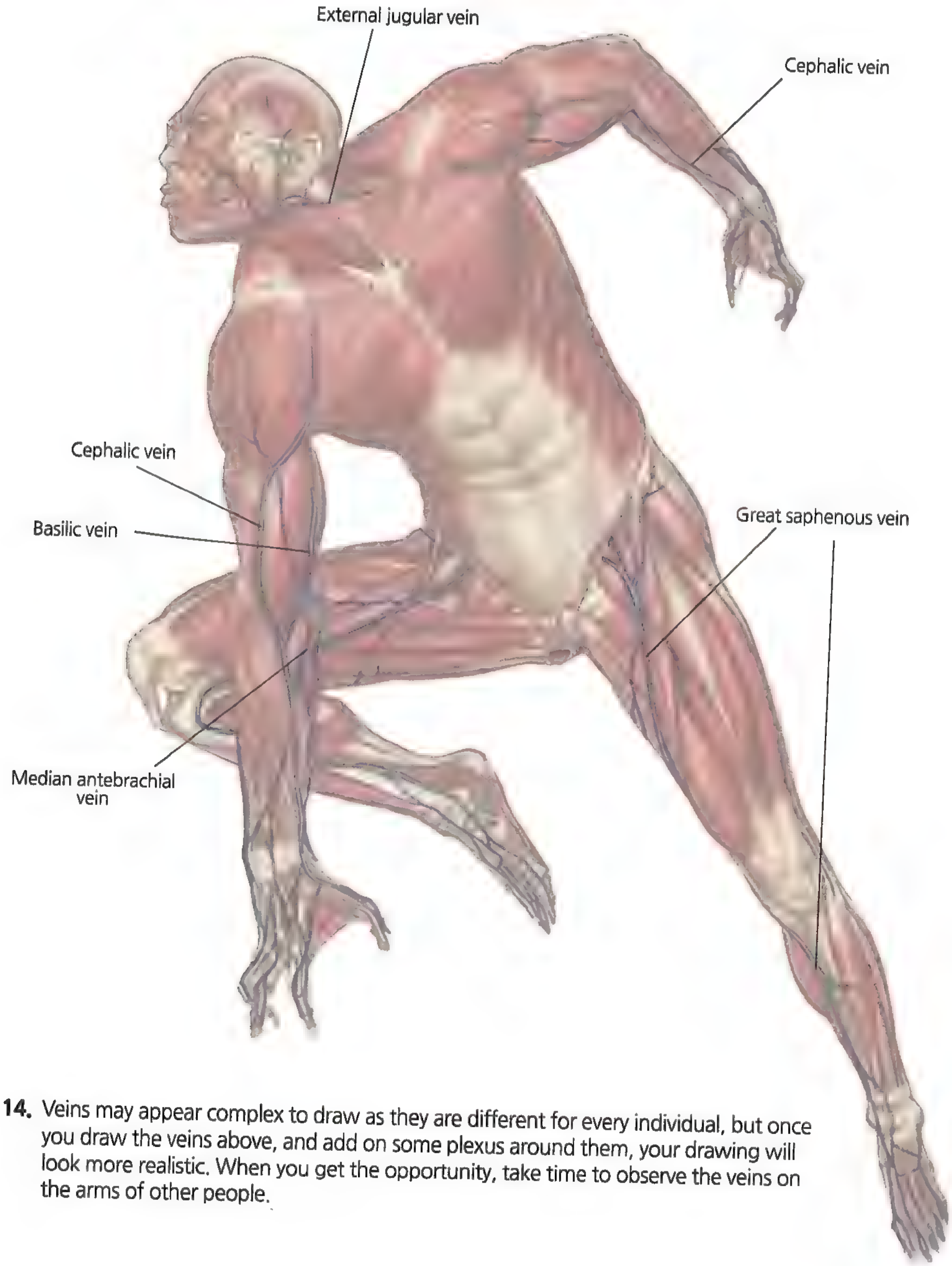
10. Let's take a look at the thigh. We have drawn the vastus intermedius previously. Centered around it, the vastus lateralis and vastus medialis are wrapped around the femur. These three muscles merge as one common tendon. They hold the patella and then continue to the tibia. Also, remember: the vastus medialis is lower than the vastus lateralis, and this forms the unique angle of the thigh. Also, note that the vastus medialis is quite thick as seen on the right leg.

11. The *ear* and *parotid gland* above the masseter are not muscles, but we will draw them because of their thickness. The wide muscle spreading from the chin to chest is the platysma. It is attached to the skin and not the bone. It works as a tendon and is used to stretch the neck or raise the chin. Draw the *extensor retinaculum* that groups together the thin extensor muscles of the wrist and ankle.



12. Let's wrap up by talking about the thigh muscles. First, the sartorius and tensor fasciae latae originate from the anterior superior iliac spine. The *sartorius* forms the border between the adductor longus and vastus medialis. The tensor fasciae latae connects to the gluteus maximus on the back and is attached to the head of the fibula. However, the *rectus femoris* in between originates from a lower point than the anterior superior iliac spine (posterior inferior iliac spine). With this, we complete the quadriceps femoris.

13. Lastly, there are the *veins* that are visible from the front view. The *artery* is deeper within the body, so it is usually the *vein* that is visible. In particular, the cutaneous vein is closest to the skin and is visible on the back of the hand or top of the foot and other areas where the muscle is developed. That is why it symbolizes 'strength,' and is often used to depict strong characters.



14. Veins may appear complex to draw as they are different for every individual, but once you draw the veins above, and add on some plexus around them, your drawing will look more realistic. When you get the opportunity, take time to observe the veins on the arms of other people.

15. Draw the curvature of the muscles, color the whole body with several thin layers of skin color, brush in some of the bigger shades, and you will have a realistic looking virtual nude model. The best way to learn for sure is to refer to nude photos available on the internet and compare each part of the body. From my experience, no matter how talented the nude model is, it is difficult to get the exact pose that I want.

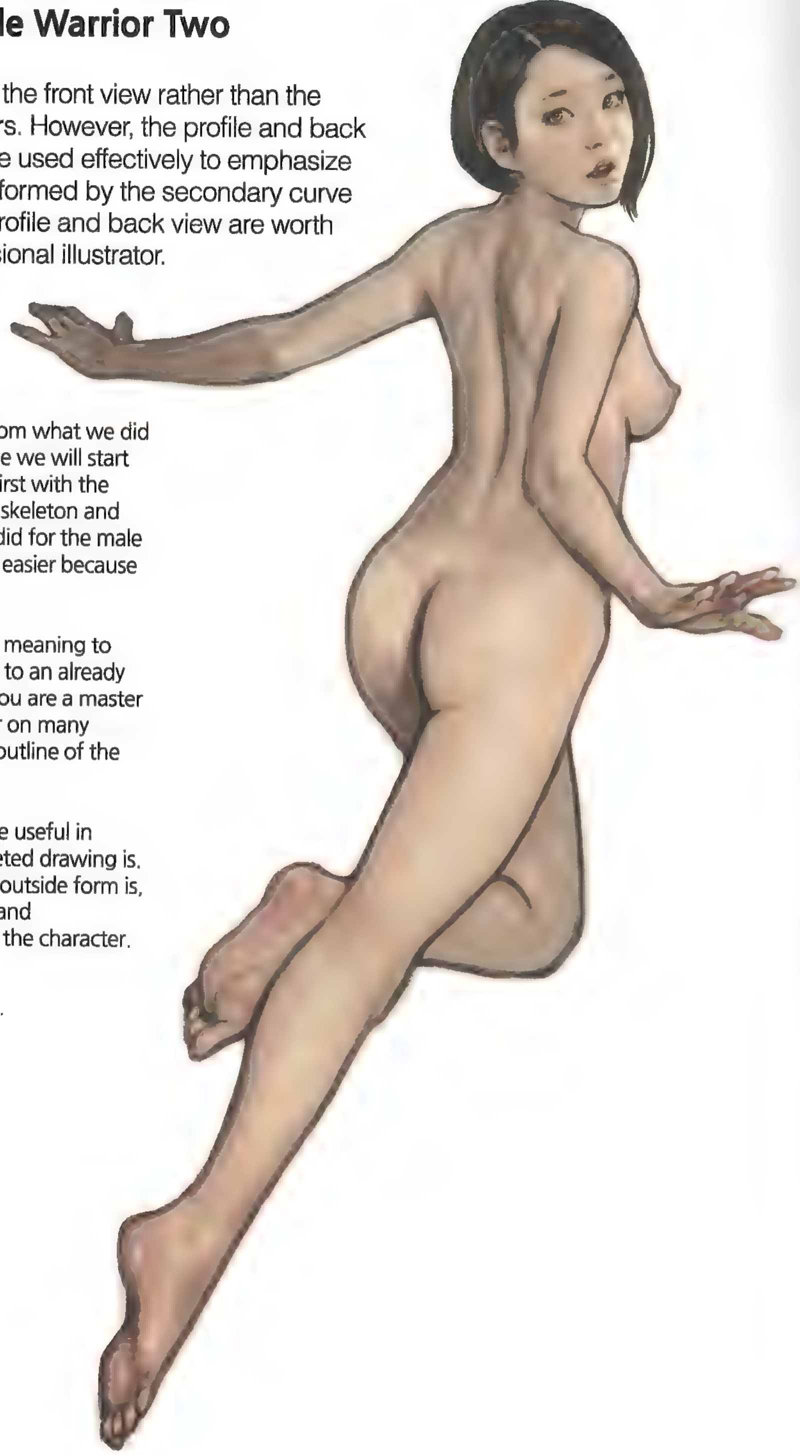
16. Once you have completed the nude illustration, try putting different apparel and accessories on top, like you would when playing with a paper doll. Usually, battle suits or armour are designed to protect the important parts of the body and to visually exaggerate the strength of the character or intimidate the enemy. You could emphasize the shoulder and trapezius that control the arm, or protect the thoracic skeleton that holds the heart and lungs.

Throughout history and in all cultures, men's attire has always had the same end purpose, albeit with some differences stemming from culture and environment—it was always used to 'expand' the body. In the end, the *body* is the most important core.

Shall we take a break and continue to the next chapter?

■Application of Drawing the Back - Full Body of Female Warrior Two

Usually artists choose to draw the front view rather than the back view of women characters. However, the profile and back view of the female body can be used effectively to emphasize a femine body line. The line is formed by the secondary curve and pelvic tilt. Therefore, the profile and back view are worth giving a try if you are a professional illustrator.



01. Taking the opposite approach from what we did with the male character, this time we will start by drawing the nude character first with the pose we want. We will fill in the skeleton and muscles in the same way as we did for the male character, but this time it will be easier because we have a clear outline in place.

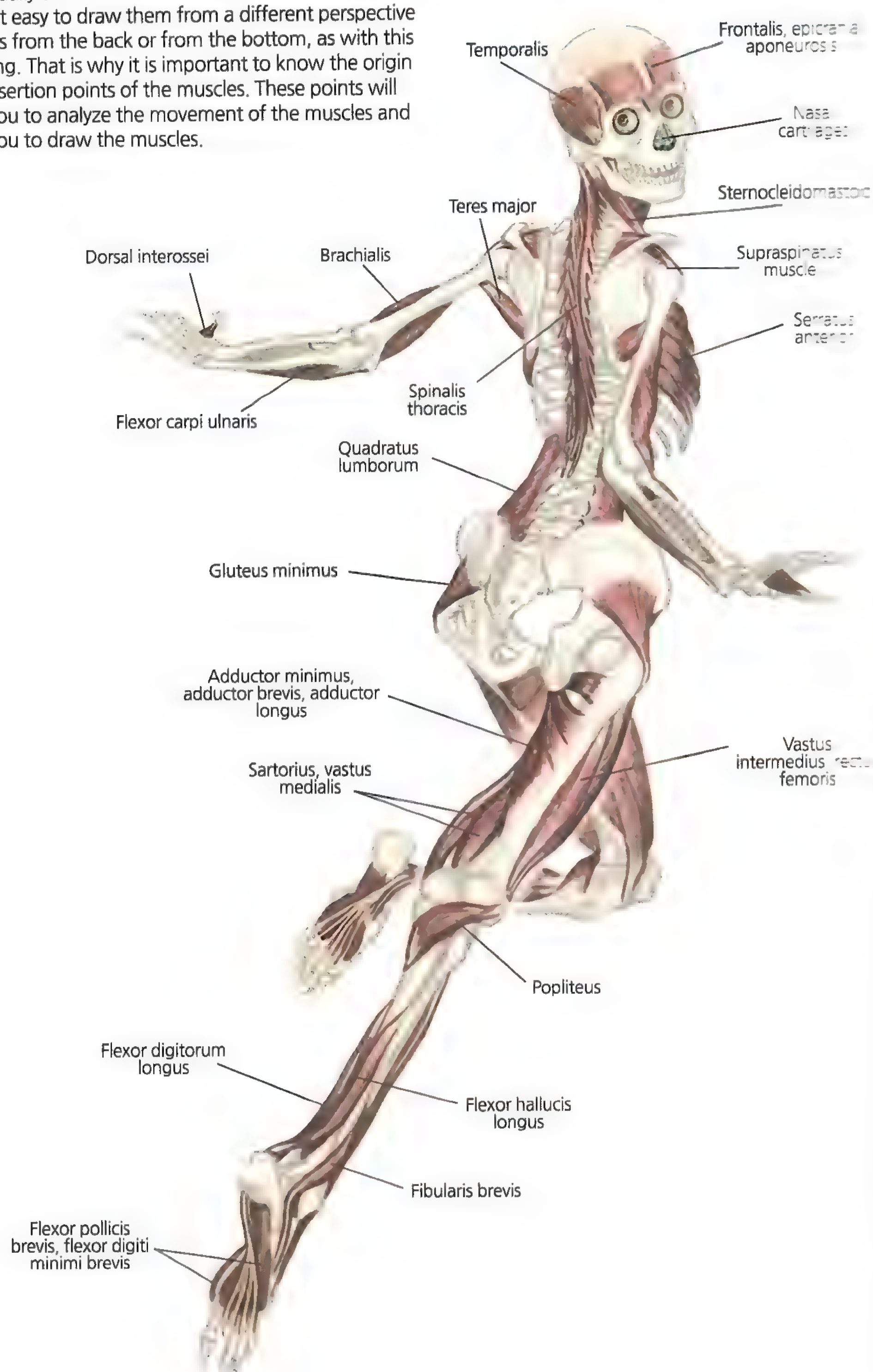
You might wonder if there is any meaning to adding the skeleton and muscles to an already completed drawing, but unless you are a master sculptor, it is very difficult to layer on many muscles and complete a perfect outline of the female figure.

Also, filling in the anatomy can be useful in verifying how realistic the completed drawing is. No matter how exaggerated the outside form is, knowing that there is a skeleton and muscles supporting it adds life to the character.

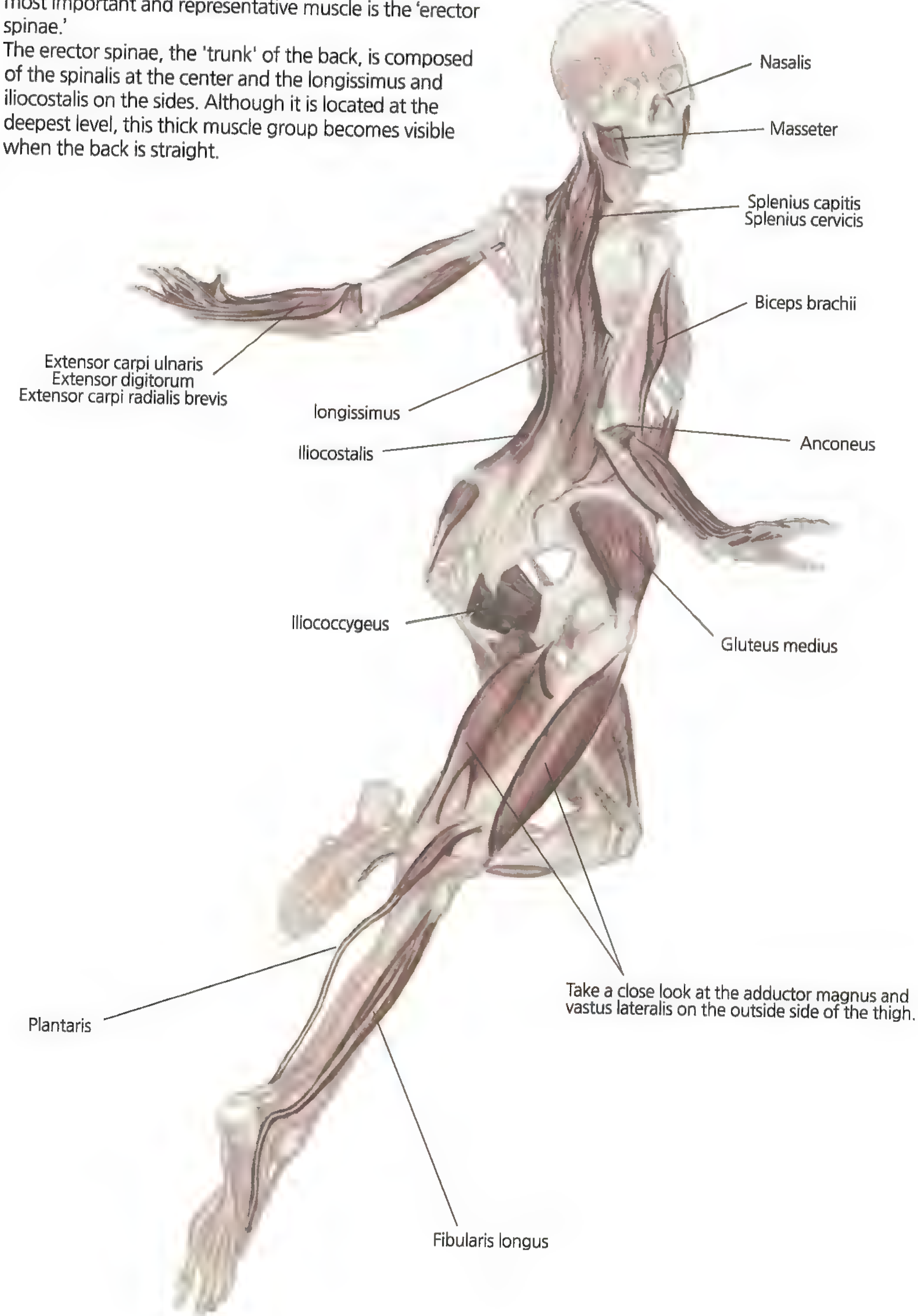
02. Make full use of your knowledge and information on the skeleton, fill in the nude character with a matching skeleton. Naturally, it is going to be difficult to fit in a perfect skeleton into an imagined pose, but if you find that you cannot fit in a skeleton into the character or that the frame is deformed, it means that the initial drawing is exaggerated.

Of course, if your intention was to draw an exaggerated drawing, then it does not matter. However, remember that exaggeration and simplification should be used only as secondary tools to emphasize the character's traits.

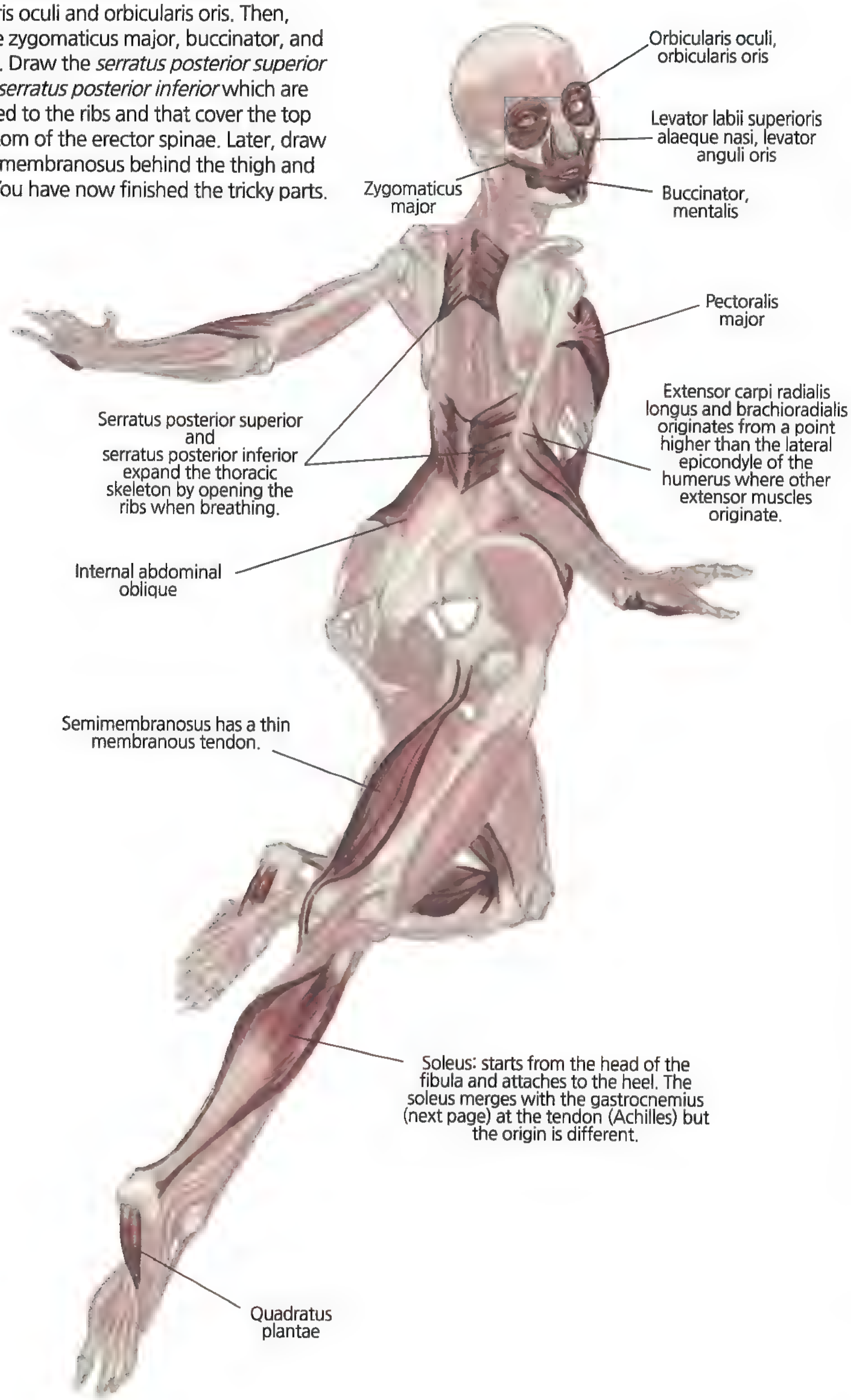
03. We usually think of muscles as seen from the front, so it is not easy to draw them from a different perspective such as from the back or from the bottom, as with this drawing. That is why it is important to know the origin and insertion points of the muscles. These points will help you to analyze the movement of the muscles and help you to draw the muscles.

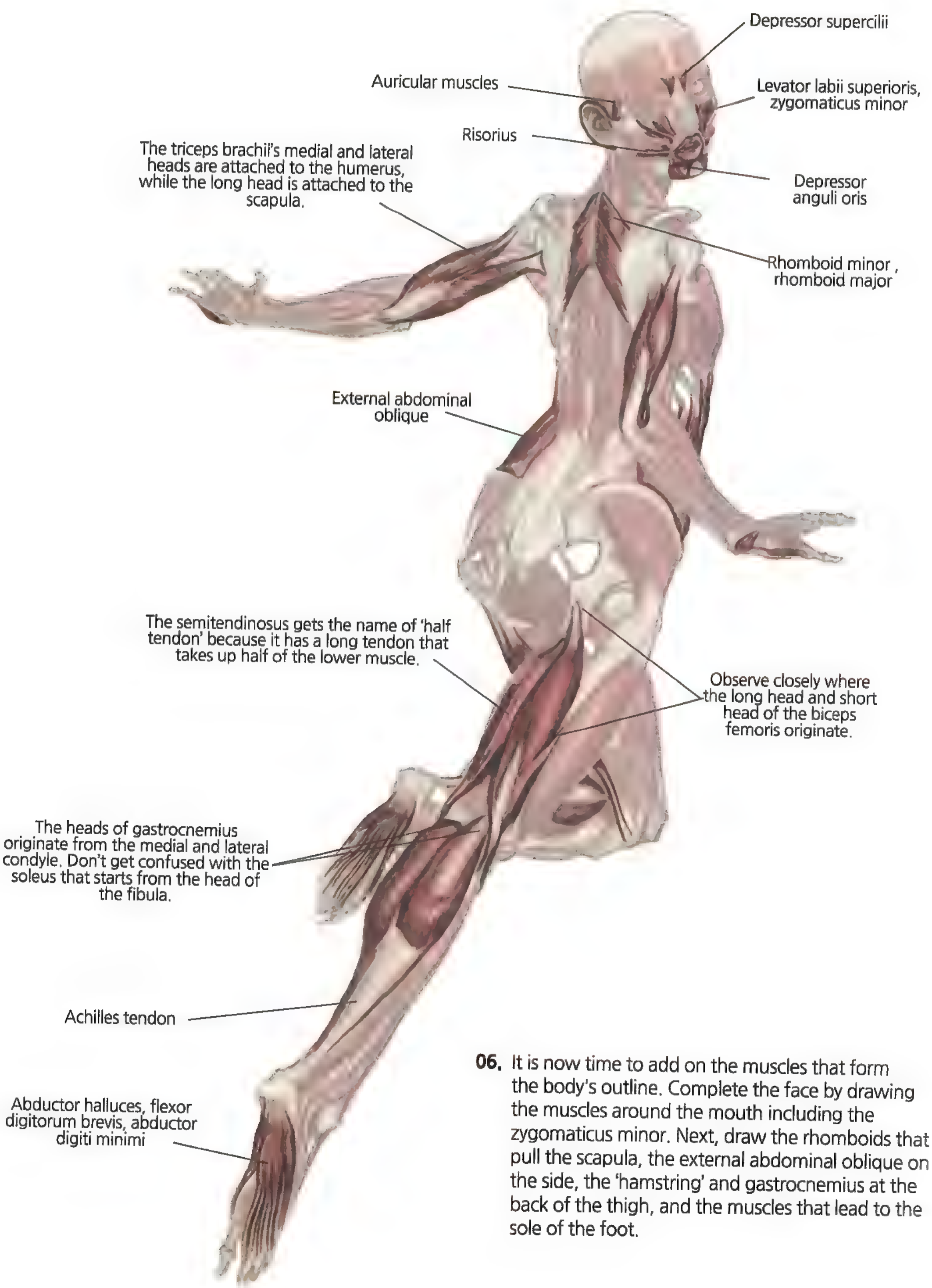


04. Among all the muscles on the back of the body, the most important and representative muscle is the 'erector spinae.'
The erector spinae, the 'trunk' of the back, is composed of the spinalis at the center and the longissimus and iliocostalis on the sides. Although it is located at the deepest level, this thick muscle group becomes visible when the back is straight.

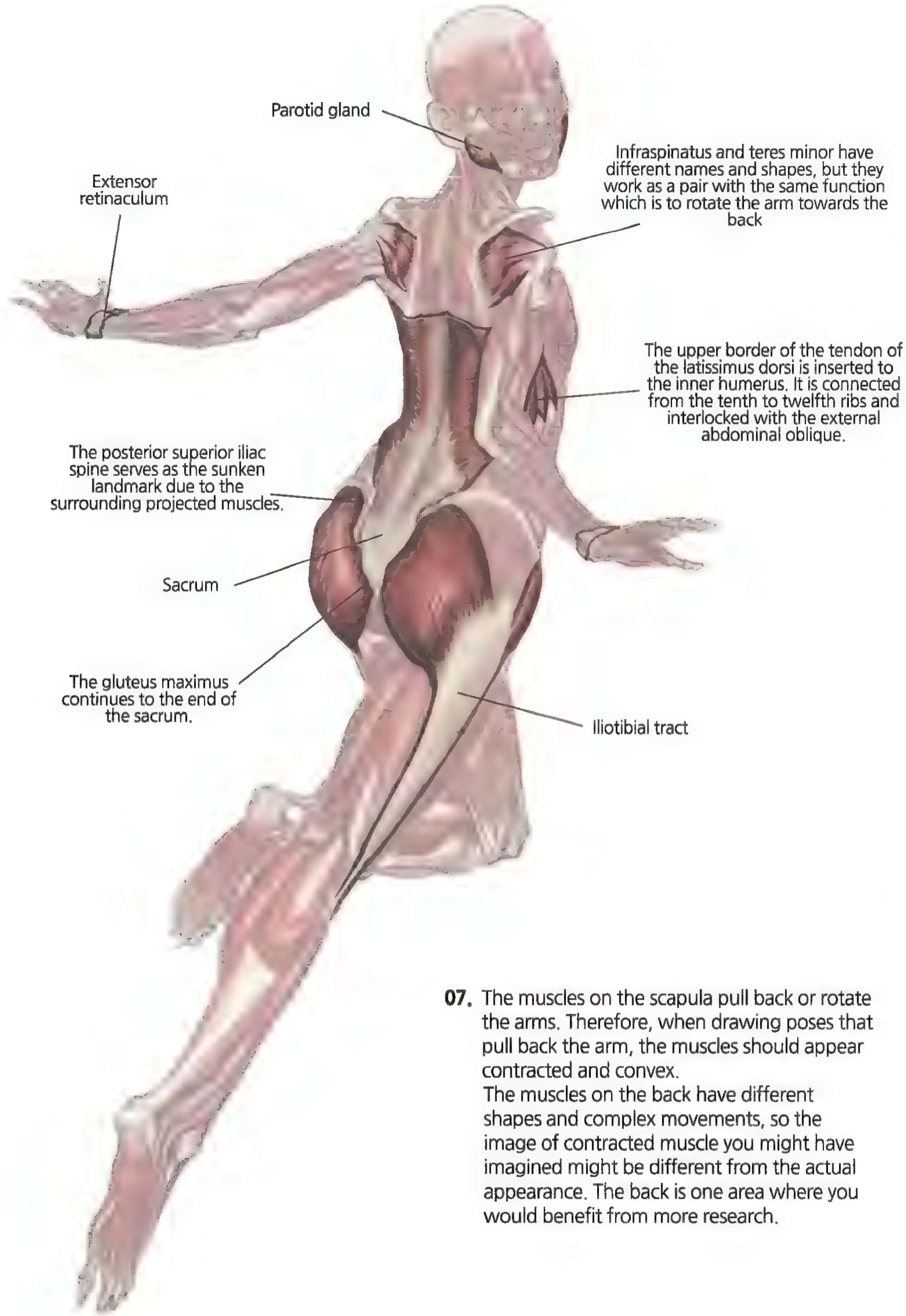


05. Draw the levator anguli oris between the orbicularis oculi and orbicularis oris. Then, draw the zygomaticus major, buccinator, and mentalis. Draw the *serratus posterior superior* and the *serratus posterior inferior* which are connected to the ribs and that cover the top and bottom of the erector spinae. Later, draw the semimembranosus behind the thigh and soleus. You have now finished the tricky parts.

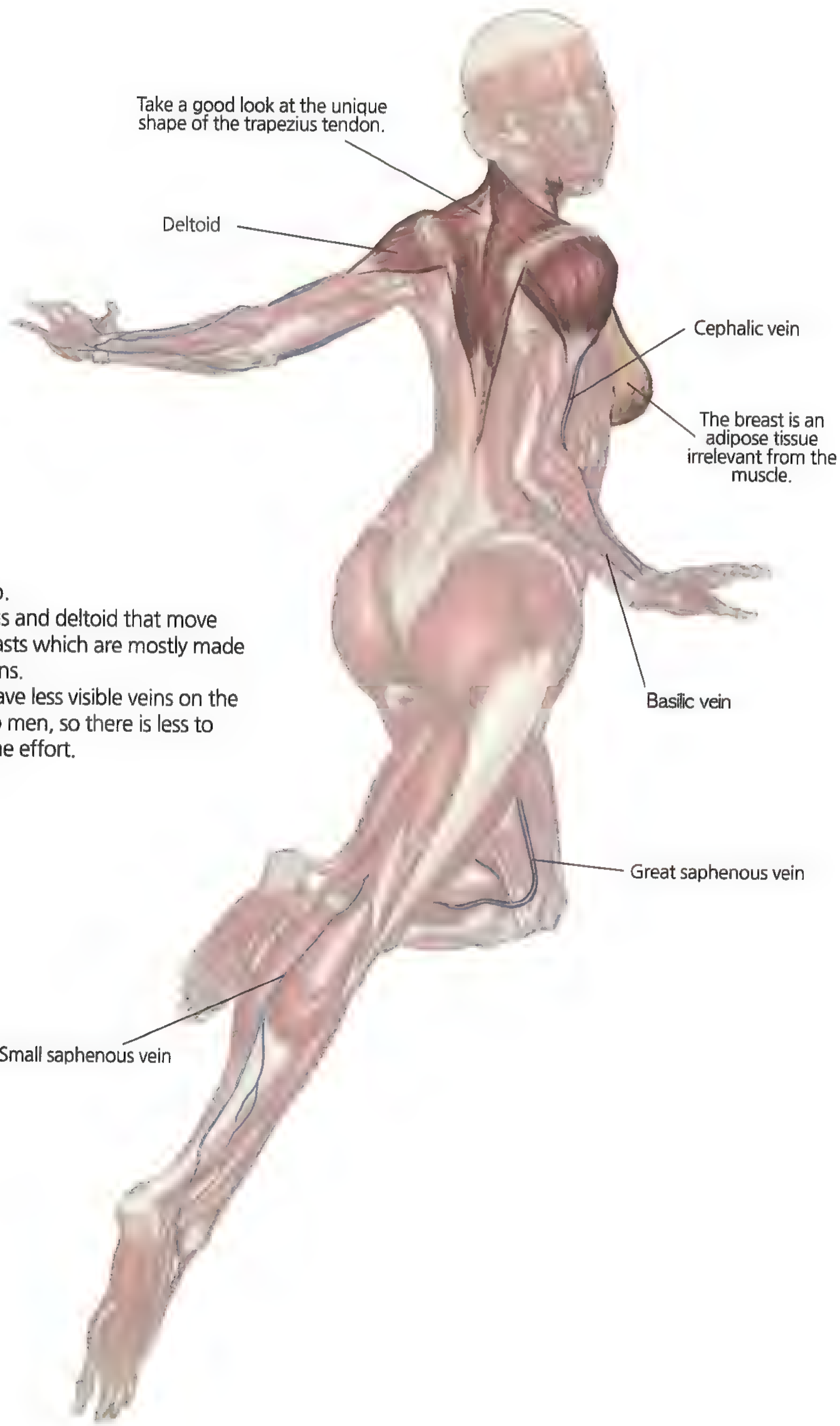




06. It is now time to add on the muscles that form the body's outline. Complete the face by drawing the muscles around the mouth including the zygomaticus minor. Next, draw the rhomboids that pull the scapula, the external abdominal oblique on the side, the 'hamstring' and gastrocnemius at the back of the thigh, and the muscles that lead to the sole of the foot.



07. The muscles on the scapula pull back or rotate the arms. Therefore, when drawing poses that pull back the arm, the muscles should appear contracted and convex.
The muscles on the back have different shapes and complex movements, so the image of contracted muscle you might have imagined might be different from the actual appearance. The back is one area where you would benefit from more research.



08. This is the last step.
Draw the trapezius and deltoid that move the arms, the breasts which are mostly made of fat, and the veins.
Women usually have less visible veins on the back compared to men, so there is less to draw. It saves some effort.

09. Now overlap the nude character drawing and the muscle drawing.
If there are no parts that stick out or do not fit, it shows that the drawing is anatomically correct.
Of course, if you consider the thickness of the skin, the muscle layer and the skin layer should not overlap completely, but for now we are drawing for practice purposes. So we can forgive this small inconsistency.

10. In the same way as we did with the male character, I dressed the nude character in a sci-fi style suit. Usually, when drawing a sexy female character, the artist thinks about how much skin to expose. But if you first draw the nude character first, you can practice thinking the opposite way which is 'how to cover the body.' It sounds like the same thing, but there is a slight difference in the end-result.

However, no matter how complex and colorful the suit, in the end it is the 'body' underneath that matters. Even if the body is covered, the viewer will instinctively see through to the body.
The instinct to see through is innate in any person who has a body.

'Motor suit' (Illustration done for F-1 Magazine, 'Pit box') / Painter 11 / 2014

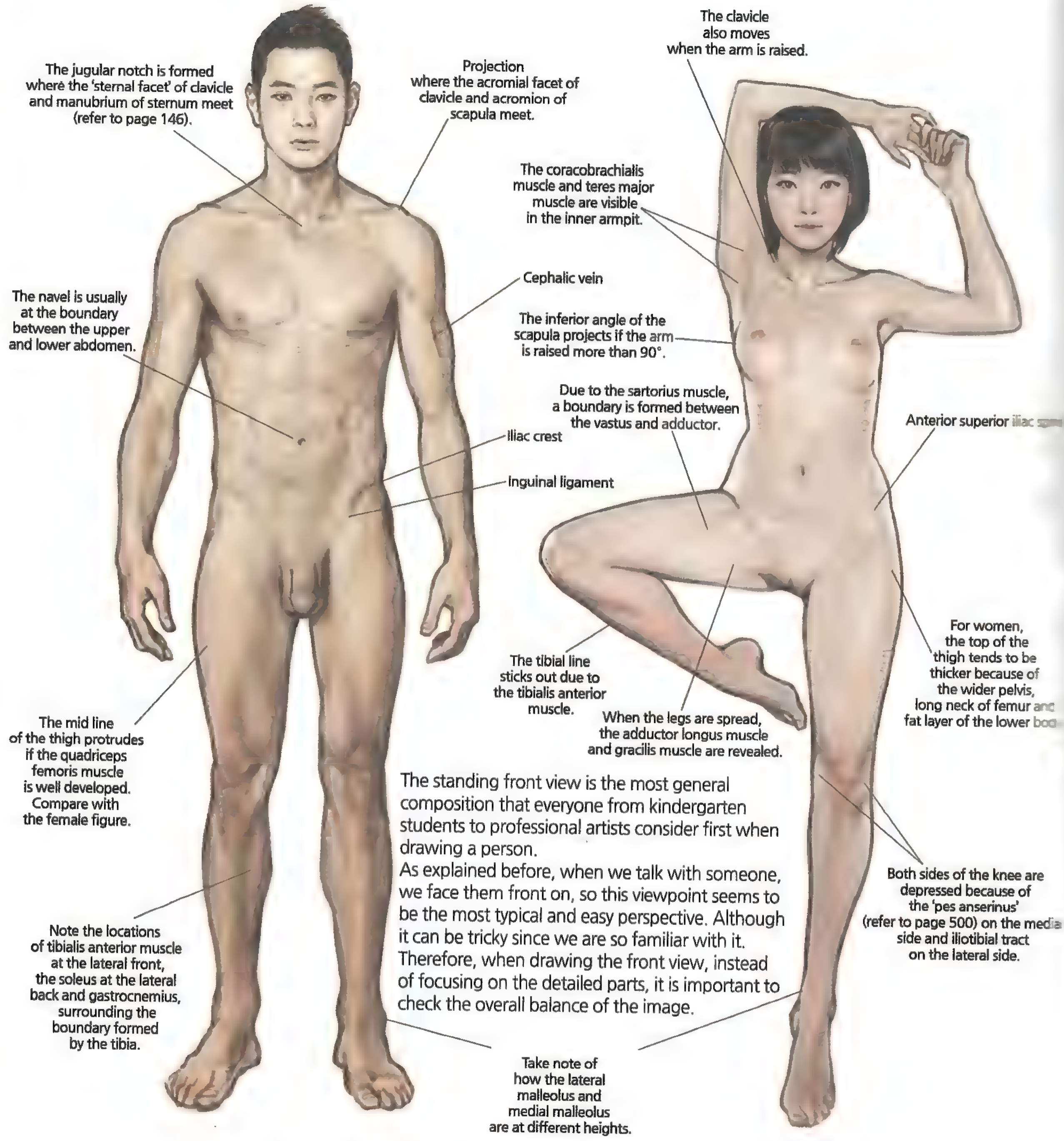
F-1 machines were personified for this work. Combining machines that are designed for extreme efficiency and the human body striving for survival is very intriguing and awesome work. Humans will continue to endlessly find new ways to evolve, as we have done so since the beginning of time, and we will be able to observe the entire process through science and art.

■Example of Male and Female Full Body Muscle

This is an illustration of the full body at the muscular layer, similar to what I drew during my end of semester exam in college when I first studied anatomical illustration. Filling in the muscles within an already existing illustration of a character assists you to understand how the muscles are operating. This exercise serves as an important basis for creating various characters. Practice using nude characters as shown in this example.

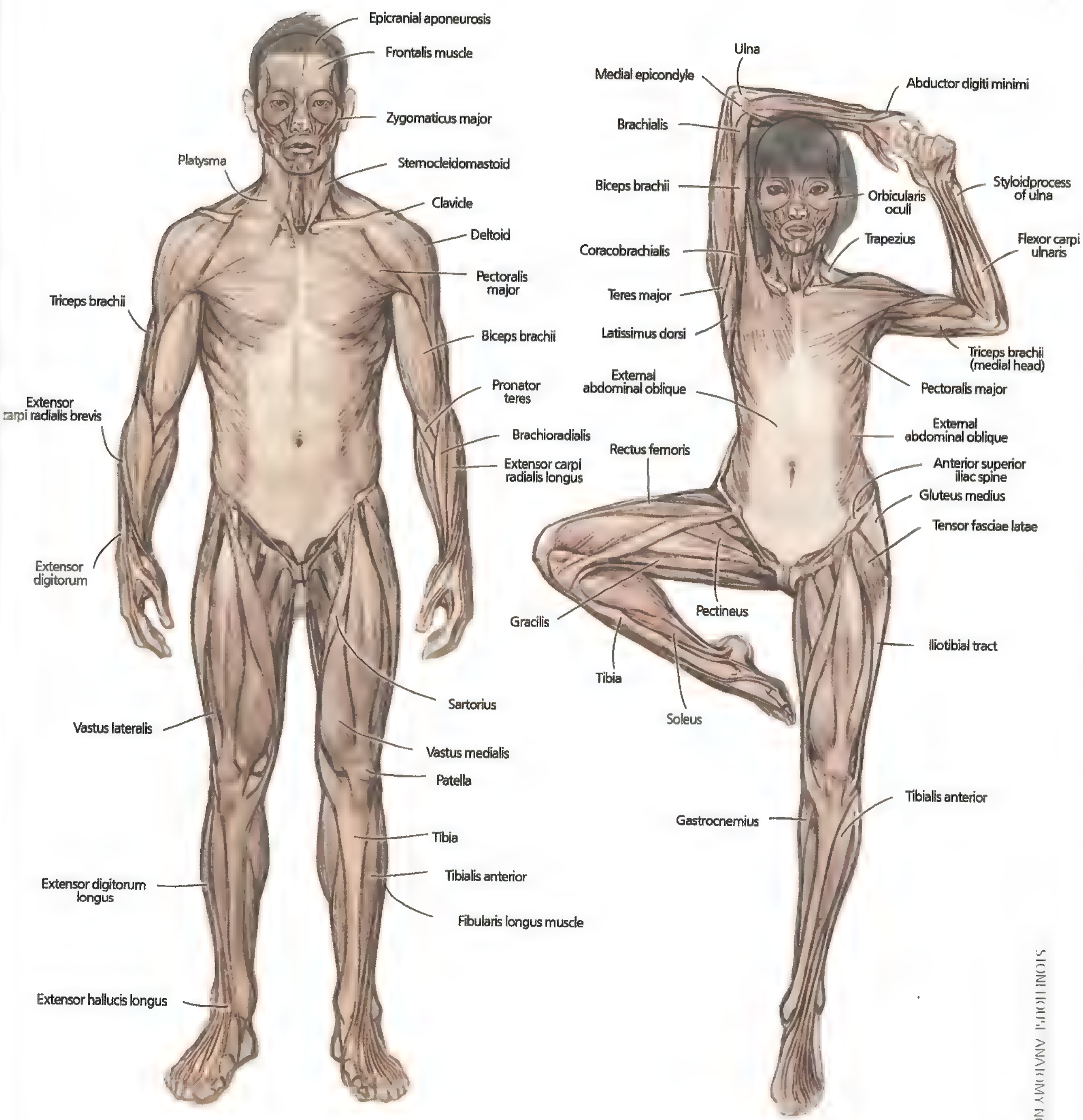
A study of upper body muscles in preparation for the 〈ShutUpandDeSLun •Basic〉 Painter 12 • pencil brushes / 2016 (model: Sungjoon Jo)

■Front View (Front side, Standing)



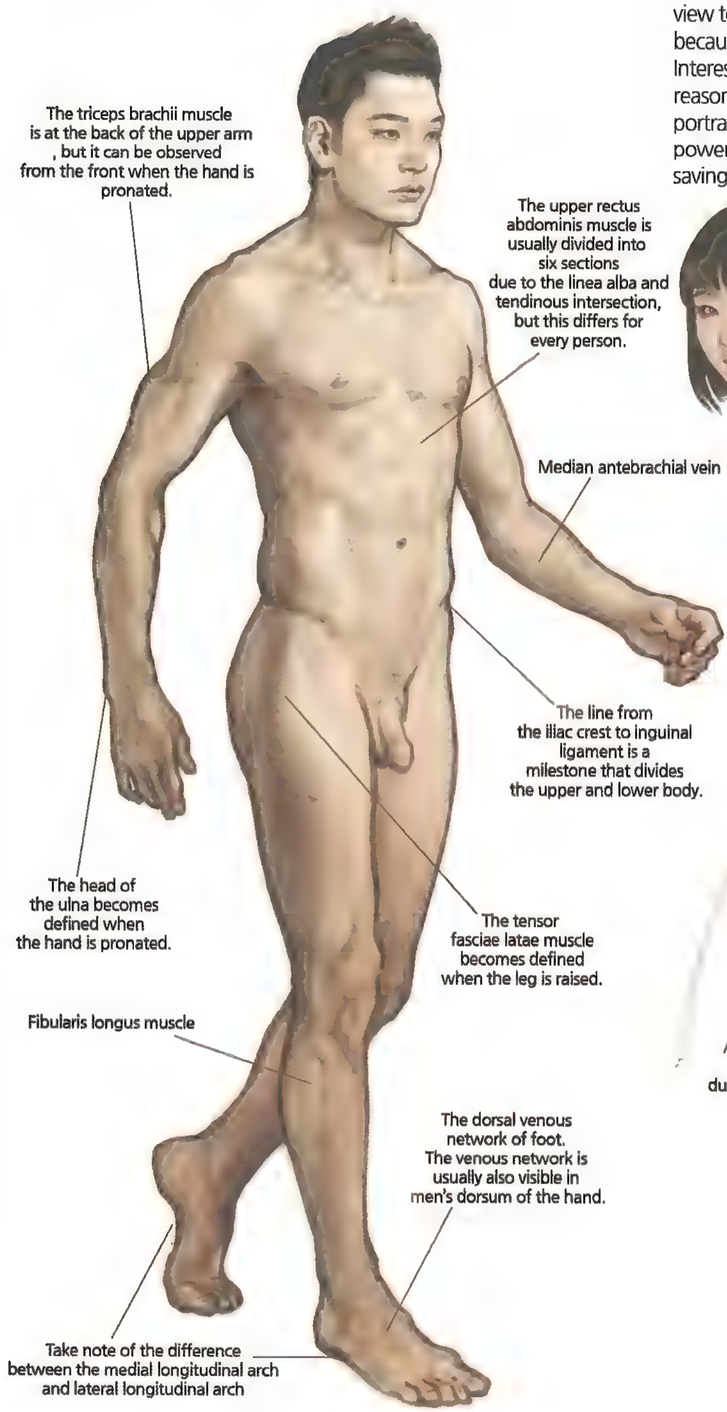
The standing front view is the most general composition that everyone from kindergarten students to professional artists consider first when drawing a person.
As explained before, when we talk with someone, we face them front on, so this viewpoint seems to be the most typical and easy perspective. Although it can be tricky since we are so familiar with it. Therefore, when drawing the front view, instead of focusing on the detailed parts, it is important to check the overall balance of the image.

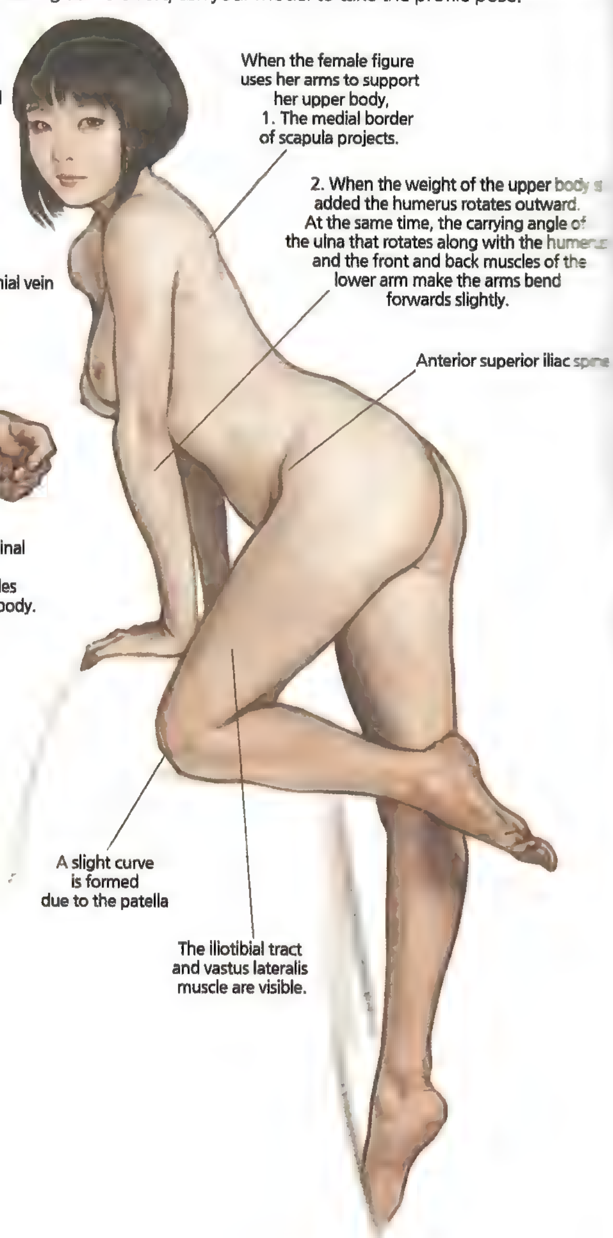
■Front View Muscles



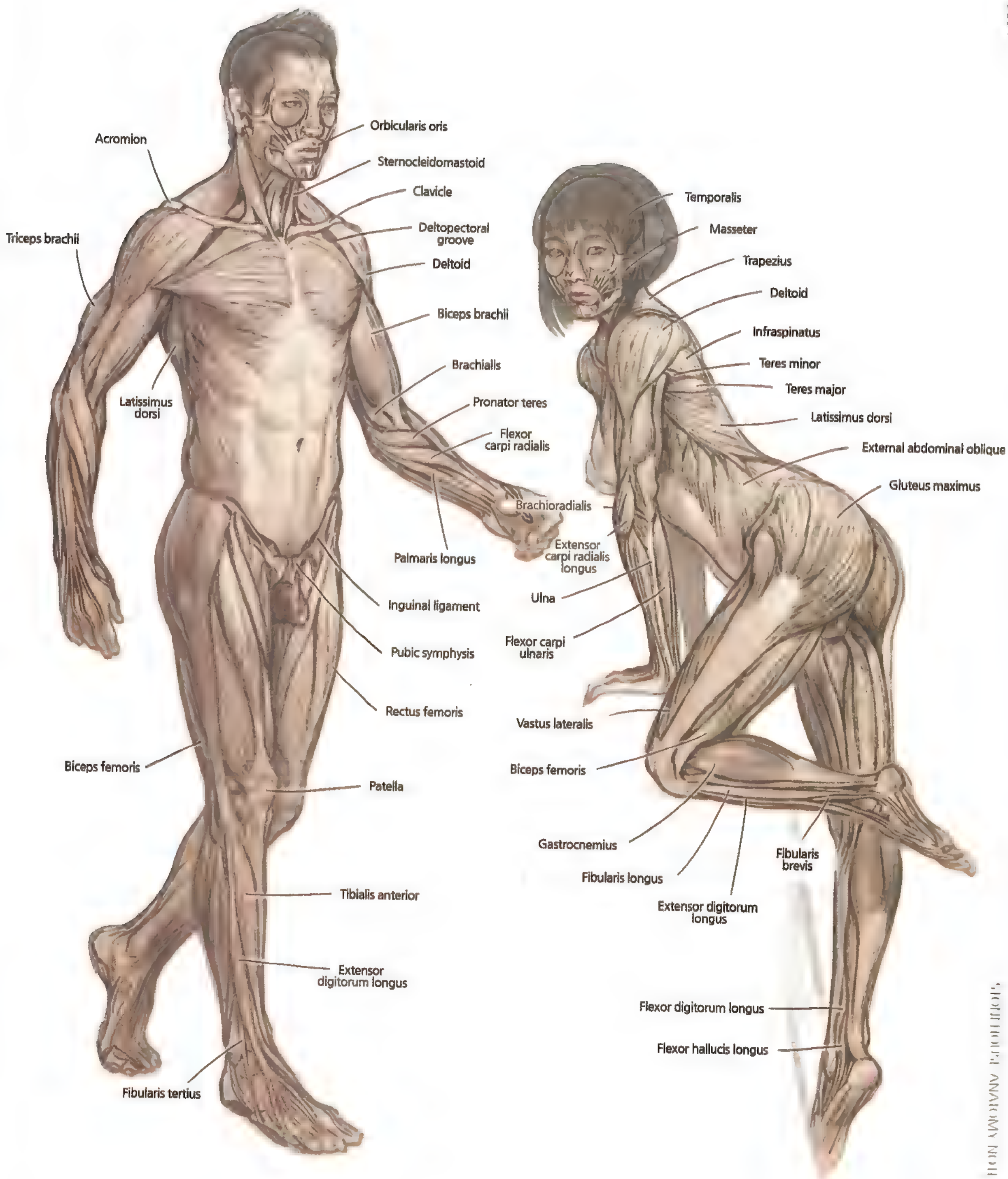
■Side View (Standing Profile)

Below are examples of profile and half-profile portraits. As mentio several times before, the profile view can be more effective than t view to show the physical characteristic of a person. It is more effec because it shows the vertebral column and various curves of the bo Interestingly, the personality and emotion of the character. It is for t reason that during the Middle Ages people of power often had the portraits drawn in profile (half-profile) to display their character an power. So, if you want to draw a character that shows movement saving some effort, ask your model to take the profile pose.

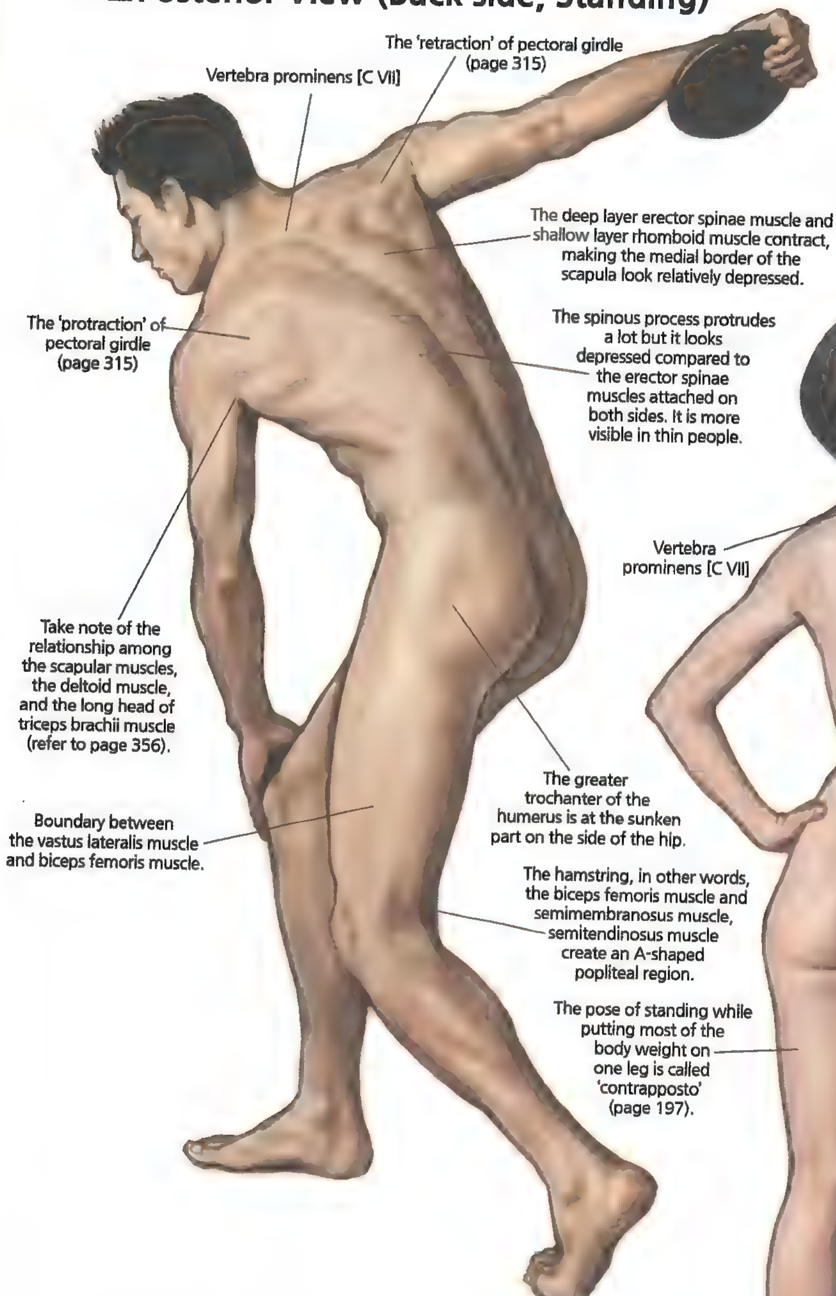


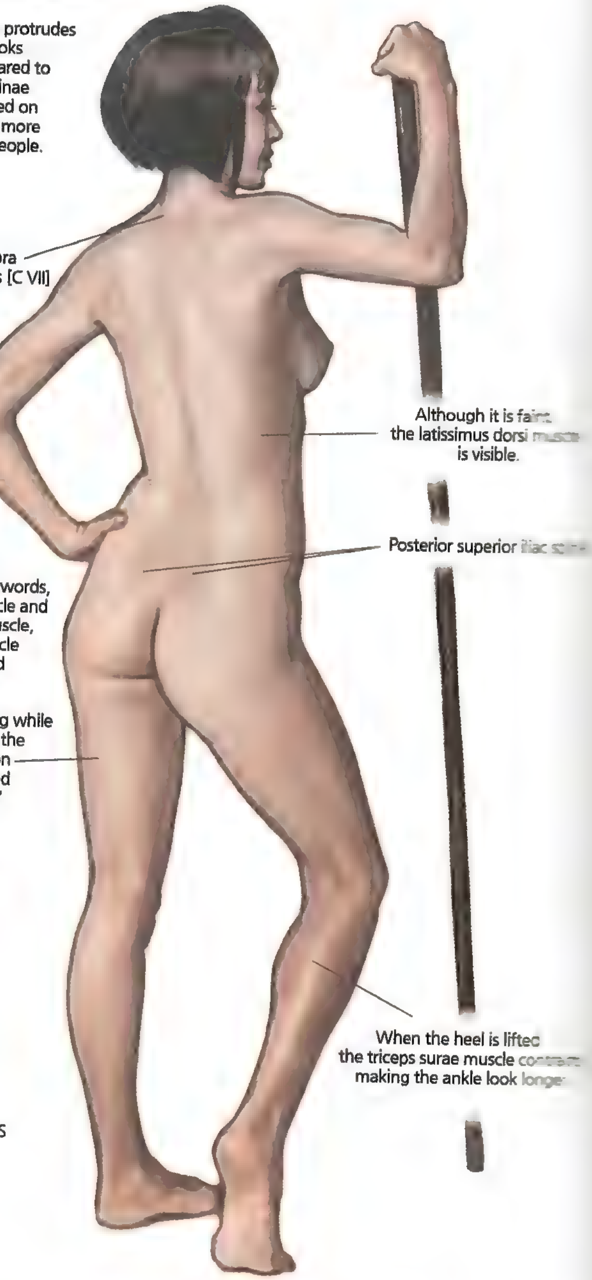


■Side View Muscles



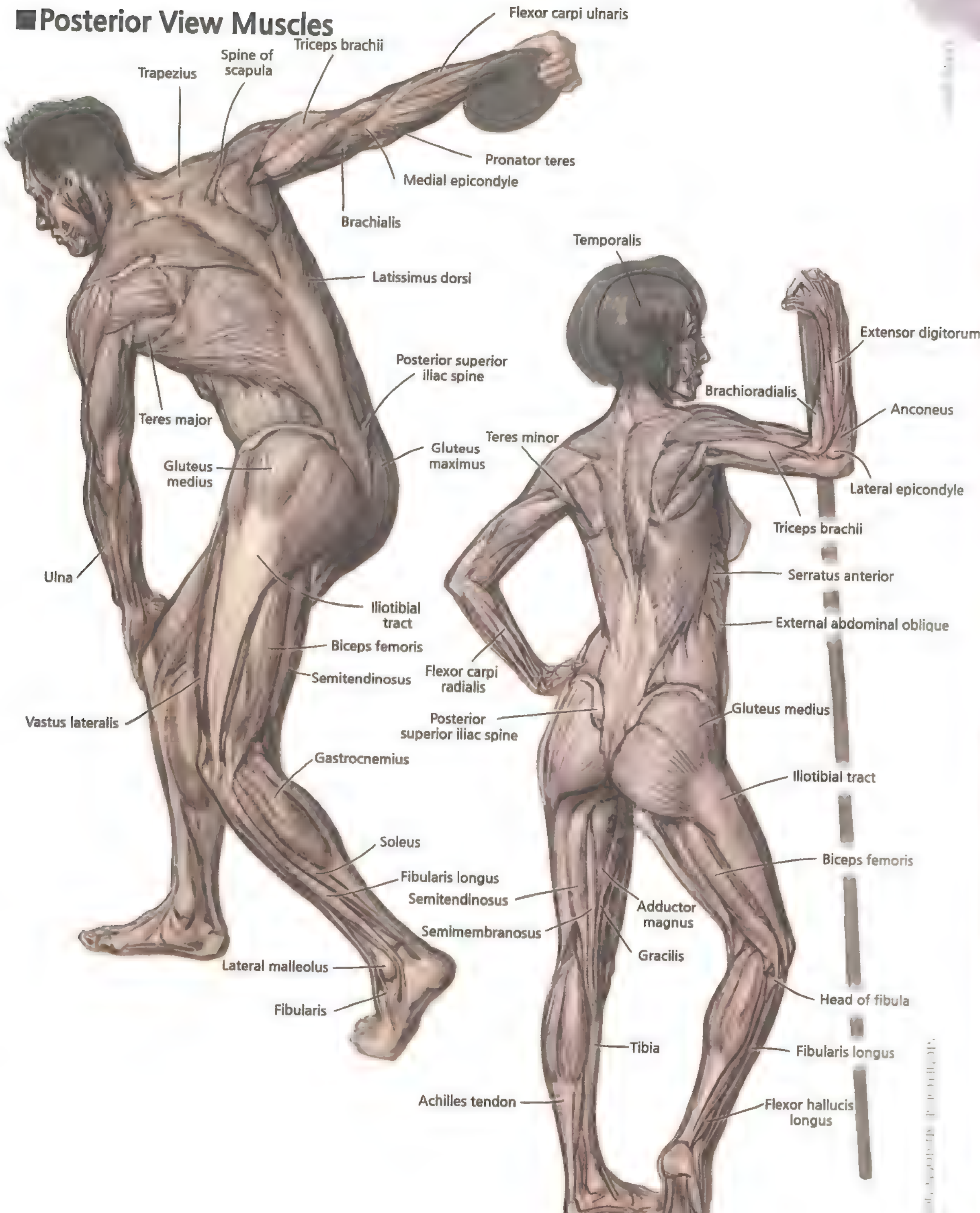
■Posterior View (Back side, Standing)



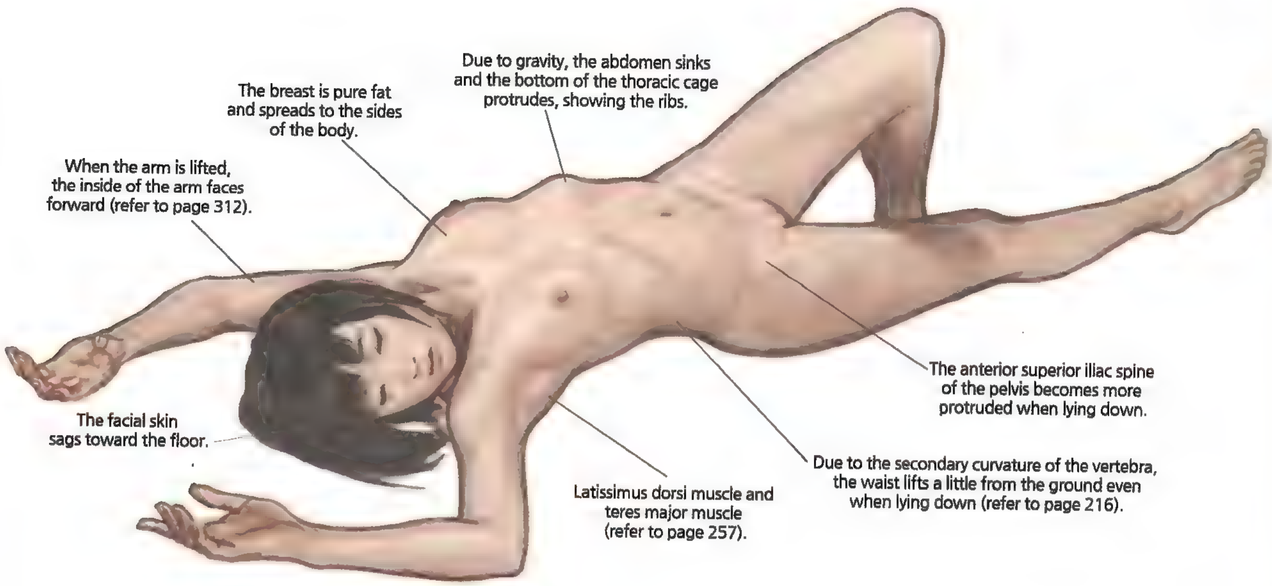


A character's posterior view does not offer much facial expression, but it is for this reason that it can be a dramatic viewpoint that arouses the imagination. Also, the broad and long back muscles have various shaped aponeuroses with complex and dynamic shapes that make drawing interesting.

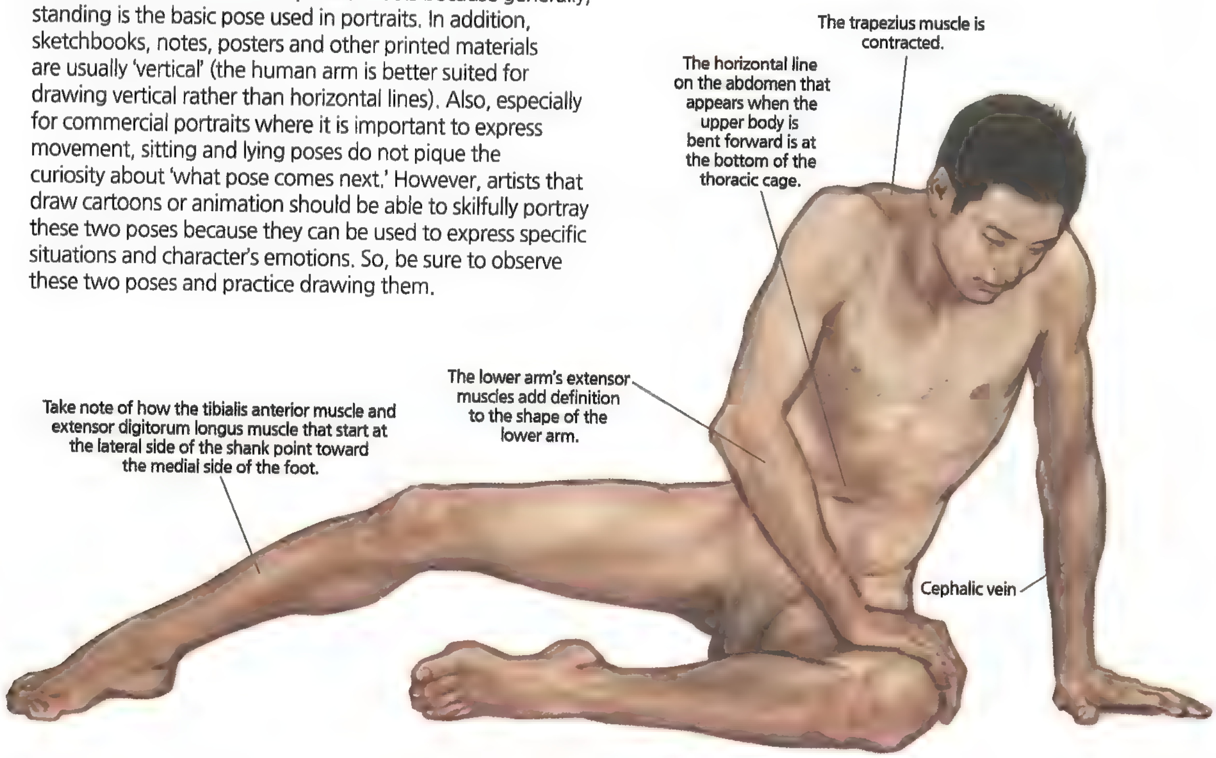
Posterior View Muscles



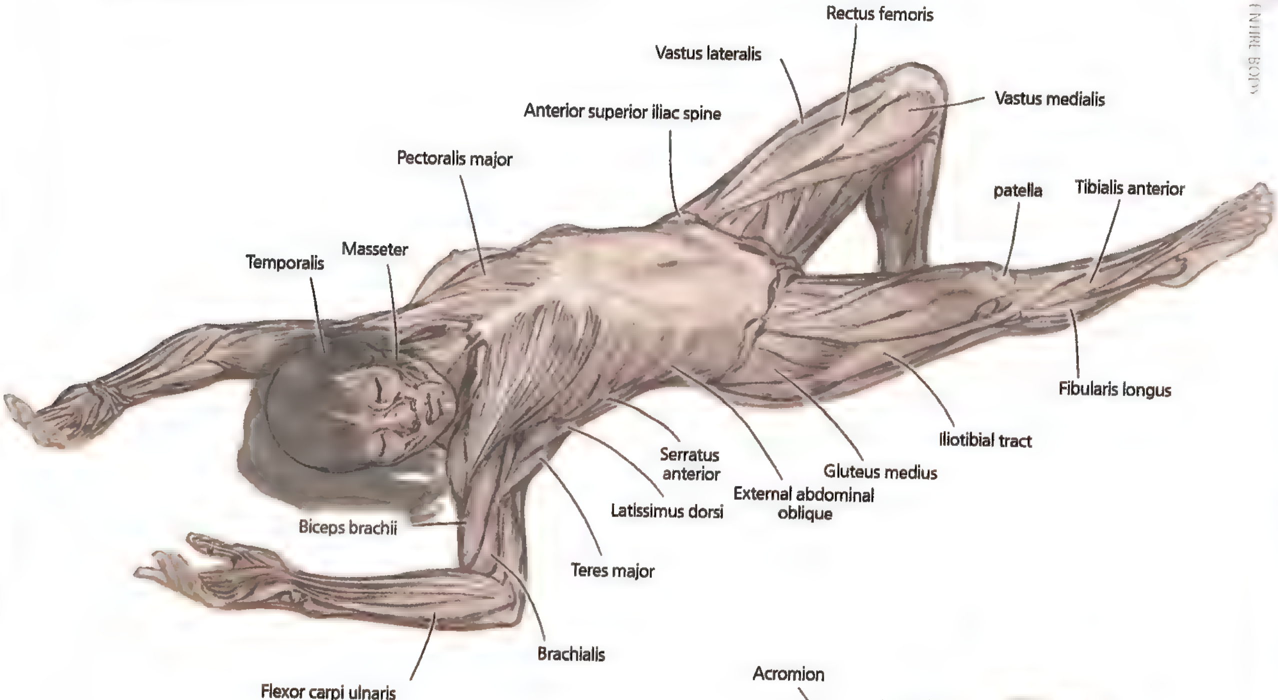
■Sitting and Lying Poses

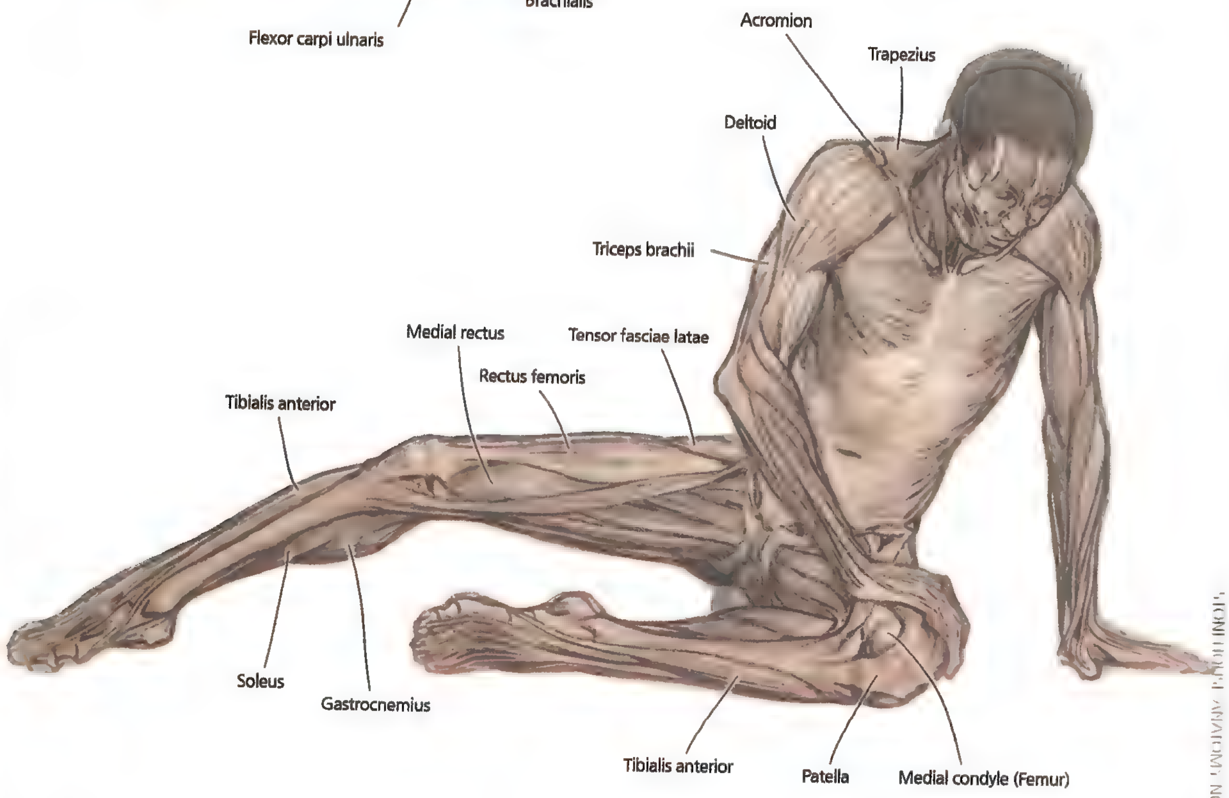


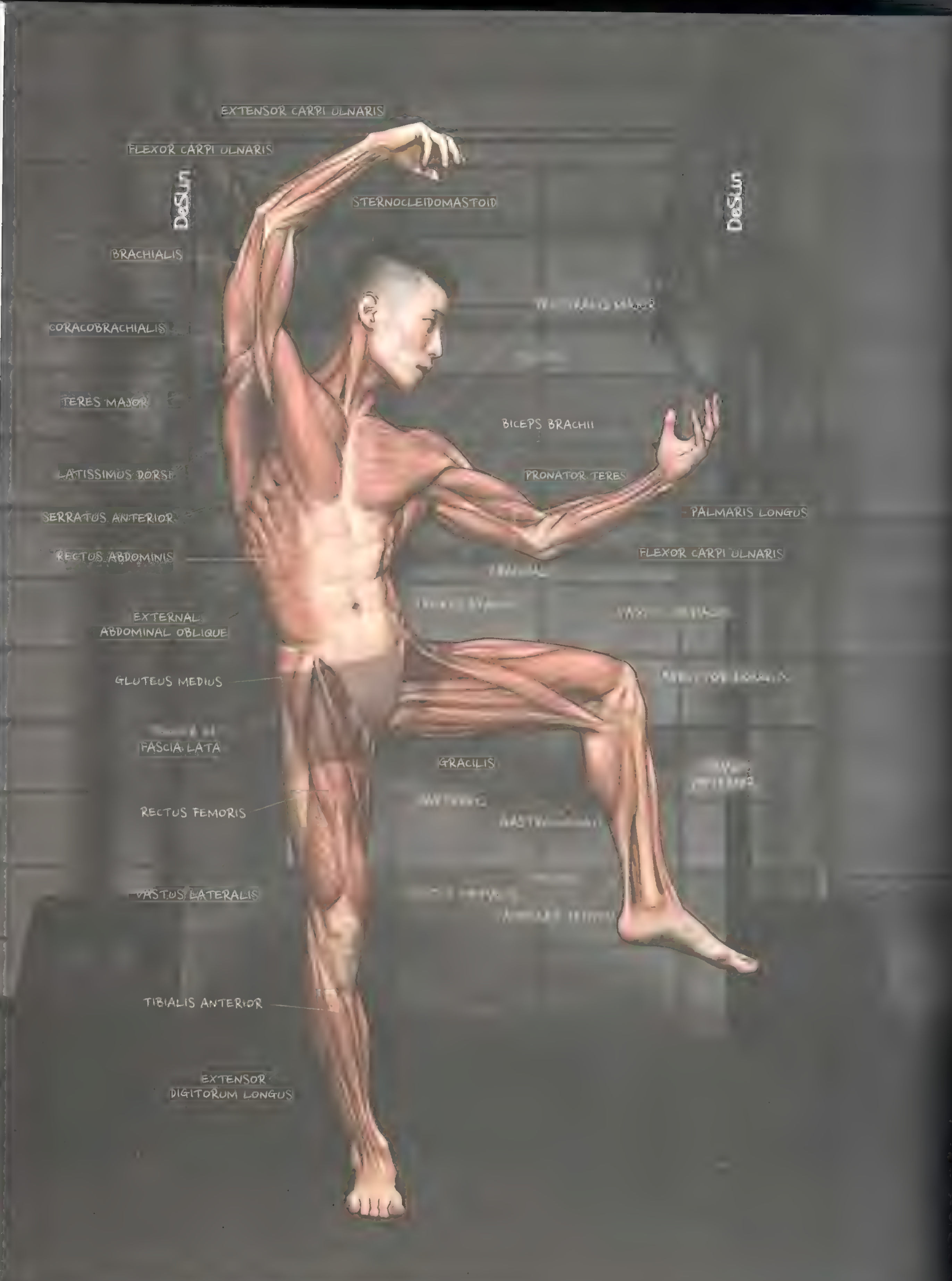
Sitting and lying are common poses in daily life, but there are few portraits drawn in these poses. That is because generally, standing is the basic pose used in portraits. In addition, sketchbooks, notes, posters and other printed materials are usually 'vertical' (the human arm is better suited for drawing vertical rather than horizontal lines). Also, especially for commercial portraits where it is important to express movement, sitting and lying poses do not pique the curiosity about 'what pose comes next.' However, artists that draw cartoons or animation should be able to skilfully portray these two poses because they can be used to express specific situations and character's emotions. So, be sure to observe these two poses and practice drawing them.

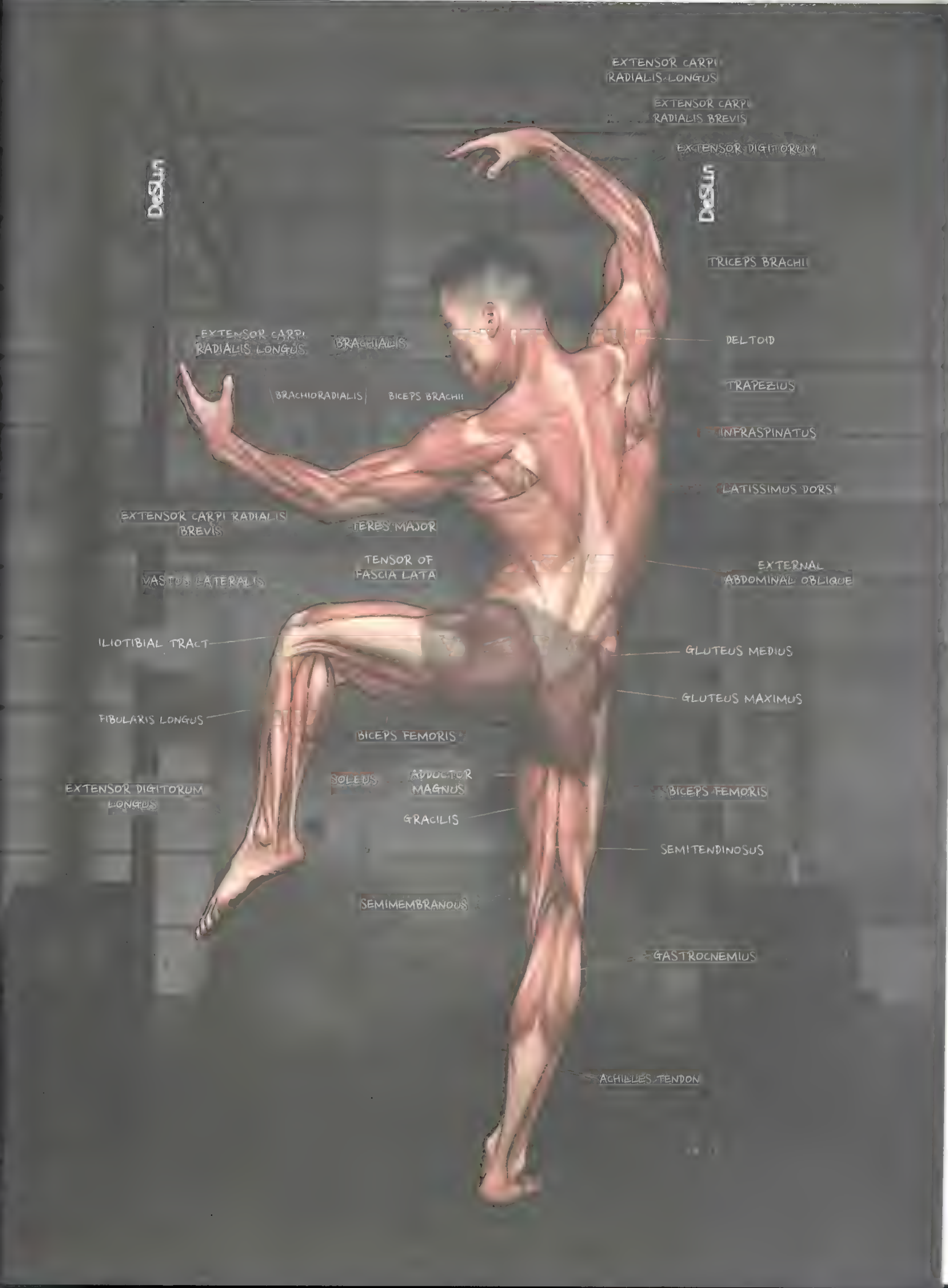


Sitting and Lying Pose Muscles






EXTENSOR CARPI ULNARIS
FLEXOR CARPI ULNARIS
STERNOCLEIDOMASTOID
BRACHIALIS
CORACOBRACHIALIS
TERES MAJOR
LATISSIMUS DORSI
SERRATUS ANTERIOR
RECTUS ABDOMINIS
EXTERNAL ABDOMINAL OBLIQUE
GLUTEUS MEDIUS
FASCIA LATA
RECTUS FEMORIS
VASTUS LATERALIS
TIBIALIS ANTERIOR
EXTENSOR DIGITORUM LONGUS
BICEPS BRACHII
PRONATOR TERES
PALMARIS LONGUS
FLEXOR CARPI ULNARIS
GRACILIS


EXTENSOR CARPI RADIALIS LONGUS
EXTENSOR CARPI RADIALIS BREVIS
EXTENSOR DIGITORUM
TRICEPS BRACHII
EXTENSOR CARPI RADIALIS LONGUS
BRACHIALIS
DELTOID
BRACHIORADIALIS
BICEPS BRACHII
TRAPEZIUS
INFRASPINATUS
LATISSIMUS DORSI
EXTENSOR CARPI RADIALIS BREVIS
TERES MAJOR
TENSOR OF FASCIA LATA
VASTUS LATERALIS
EXTERNAL ABDOMINAL OBLIQUE
ILIOTIBIAL TRACT
GLUTEUS MEDIUS
GLUTEUS MAXIMUS
FIBULARIS LONGUS
BICEPS FEMORIS
SOLEUS
ADDUCTOR MAGNUS
EXTENSOR DIGITORUM LONGUS
BICEPS FEMORIS
GRACILIS
SEMITENDINOSUS
SEMIMEMBRANOUS
GASTROCNEMIUS
ACHILLES TENDON

Epilogue

"Could you recommend me an easy anatomy book?"

This is a question I got repeatedly from younger classmates and students throughout my professional life. I could not answer them because I had never seen such a book. So I joked around and used to answer like this.

"Wait and I'll write that book for you."

Of course, it was a joke.
Actually, there were many 'good' anatomy books out there. Louis Gordon's or Andrew Loomis' books for one, and if one ventured a little out of the art field, there were many anatomy books for professionals in the medicine, health, or physical education sections of large bookstores. Admittedly though, these books are very difficult.
As an artist, I tried to study anatomy too because it is essential for artists. So I kept a stack of anatomy books and glanced over them now and then. However, regardless of how I tried to approach it, anatomy was not an easy subject. The word 'anatomy' in itself conjured up images of something grotesque or fearsome and there was just so much to memorize.
I was about to give up on studying anatomy in earnest because I thought "I've been drawing since I was young, I'll be fine if I have a rough idea of what the human body looks like. I will just practice a lot by sketching."

Then, during my sophomore year in college, I attended a 10-hour long anatomy lecture given by the famous artist Saeyoung Oh. His sketches were so thorough and perfect that he was known as the 'cartoonist that even draws dried dung particles stuck on a cow's butt.' The lecture was an eye-opener for me. During those two days at the sloped lecture hall I saw the big whiteboard fill up with endless drawings of bones and muscles. I realized that I had been denying my ignorance.

It is said that 'to know something means that you realize what you don't know.' When I didn't know anything I didn't care, but once I got a glimpse of what I didn't know, I became impatient to learn. Luckily, the following year, Professor Saeyoung Oh taught a Human Anatomy class. I, eager to learn, absorbed the weekly classes that introduced each part of the human body. I had never been a studious student, neither in elementary, middle or high school, but I was enthusiastic about human anatomy. I volunteered to take the class again in the following semester, and even went to the library to study note-filled notebooks. Thanks to my enthusiasm, I became close to the professor, and under his guidance, my drawings improved little by little. In a nutshell, I started feeling more confident about drawing people.

It was my newfound confidence that helped a computer illiterate like me to publish "*Seok's*

Painter Series," a book on how to use the drawing program Painter.
I received undeserved recognition for having contributed to the popularization of the program Painter, which at the time was not very well known to the public. I was immediately offered a proposal to publish a sequel because there was a program version upgrade, but I hesitated. If I were to prepare a sequel, I would need to dig deeper into the program, but I was still not that comfortable with computers. I had many tug-o-wars with the publisher.

Then, at the proposal of my teacher and artist Jaedong Park, fate had me join a cartoon drawing study group (now called 'Dal Toki') formed by artists Saeyoung Oh, Gwangsung Kim, and Heejae Lee, and joined by the drawing master Junggi Kim. In this dreamlike setting, we all loudly agreed that the anatomy books for the arts that Korean art students referred to were mostly written from the Western perspective and that they were difficult to study because they did not fit well with the Korean way of thinking.

Like the saying goes, strike while the iron is hot, we agreed that we should start by signing a book contract. I remembered the Painter book contract that I had almost signed. I still remember the publisher's words over the phone.

"What! You want to publish a book on anatomy? What about the Painter book? "
The logic I presented to him was that while the Painter program had a specific target audience, an anatomy book would be relevant to everyone who draws. The publishing agent agreed, but he seemed worried about how long it would take for me to prepare the book.

At first, I thought the book content would be simple, just a neater version of the messy notes I had taken at Professor Saeyoung Oh's class. So I estimated that one or two years would be enough for the book. But that was a big miscalculation. As I wrote the book, small but fundamental questions began to come up one after the other, and I could not find a clear answer to the questions. It brought back my childhood memory of how I had been curious but frustrated about the appearance of my dog's hind legs in elementary school.

I had told everyone that I would take charge of the overall framework of the book, but I made little progress, and the book project was put on the backburner. The artists that I had asked to participate in the book project were famous artists who were already busy with their own schedules, so I could not ask them to remain on standby indefinitely. In the end, I came to burden the anatomy book by myself. A lot of time passed well beyond the couple of years I had first planned on completing the book.

The publisher had almost given up on trying to pressure me. One day, Dr. Dongseon Shin, an acquaintance of mine who was an artist, musician, 3D expert, and anatomist at the same time, pointed me to an anatomy class held by Yonsei Univ. Dentistry Anatomy class for the general public. The 'Da Vinci Academy,' as it was called, was a heaven-sent opportunity to meet artists who could help me.

Through the Da Vinci Academy, I met professors Heejin Kim and Kwanhyun Yoon who gave me heartfelt advice and encouragement to tackle the book project once again. This led to me to another valuable opportunity to participate in the Korean Association of Physical Anthropologists Conference. There, the group's director and expert on Korean anatomical terms Professor Kiseok Ko of Konkuk University and Doctor Soonwook Kwon of Korea University, who were enthusiastic about drawing, became loyal supporters. With all of their help, the outline of my book slowly started to take shape.

However, having mere theoretical knowledge about the shape of the bones and muscles was not enough to know the actual mechanisms of the body and how these mechanisms appeared to the eye. But where there's a will there's a way. My wife had just started taking personal training lessons, and I came to know the famous trainer Sungjoon Jo who was also the author of the series

Shut Up and DeSLun Basic. With his help, I was able to finish the book in nine years. Coach Jo willingly used his body to show me about body mechanics. To be sure, he was the best model one could have to see how the body mechanics appear on the outside.

As such, this book was created with the help of numerous experts, but there are many parts that were written solely based on the view and judgment of yours truly, a humble and ignorant artist. So, even as I write this epilogue, I feel a little unease.
Because even given the fact that it was written by a humble individual, anatomy is still a very heavy topic that deals with the basic science of the human body and cannot be easily simplified. So I am really worried that this book might spread misleading information to instructors, students, and aspiring art students.

However, I find small solace in thinking that this book and my efforts will have some significance

because history shows that all academic disciplines go through many trials and errors and that in the process of filling up infinite space, it contributes to the expansion of human wisdom, and that this was achieved not only through discussions among scholars, but also through interactions with artists and engineers.

During the nine years of writing the book, I have laughed and cried and experienced many changes both internally and externally while living in the world of "anatomy." Mankind's evolution will continue, and I also have a long way to go. I ask that my readers support my growth as a head of a family, father, and artist, and I would like to deeply thank all the people that have supported me and this book.

I would like to thank Mr. Okhyun Choi, the Managing Director of Sungandang publishing company who waited patiently for ten years for a book that did not seem to ever materialize; editor-in-chief and trusted friend Jonghoon Park; former assistant director Dongjin Choi who went through a lot of headaches; my friend Jungwoon, Dongsu hyung, and friends from Dal Toki group who all encouraged me; my father-in-law who was always there to help me; my drinking buddy and reliable advisory committee member Dongseon Shin; Dr. Soonwook Kwon; Professors Kiseok Ko, Heejin Kim, and Kwanhyun Yoon who provided me detailed feedback about the book; Professor Sunghoon Park of Dongju University Department of Physiotherapy who proofread this book for typos after publication;

Dr. Youngcheol Chung from the Department of Dentistry who provided additional comments regarding facial anatomy; my eternal teachers Professors Jaedong Park, Heejae Lee and Kwangseong Kim; Professor Saeyoung Oh, who passed away before seeing this book; artist Regun Lee, my precious rival and the best wife in the world who had to go through a lot of difficulties during the making of this book; my proud son Taerang, my mother-in-law who was there to support her poor son-in-law; my mom; my younger sister Bogyeong; my aging dog Doldori; my dad whom I miss very much and who would have been so happy to see this book, I dedicate this book to all of them.

January 2017
Junghyun Seok

My anatomy notes from college that became the basis of this boo

Index

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F

A book on anatomy that hits the nail on the head.
For beginners and professionals alike, this book has a lot to offer to anyone who reads it.
(I'm sure that my appearance in this book increases the credibility of this book! Ha!)

Jung-Gi Kim (Drawing Artist)

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